

SOUTH AMERICA

AN ECONOMIC AND REGIONAL GEOGRAPHY
WITH AN HISTORICAL CHAPTER

by

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With 51 Maps and Diagrams

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PREFACE

THIS book has been written primarily for the use of University students and of those interested in the reasoned study of the geographical features and the resources of South America, and of the industries and general economic life of its various parts and peoples. An effort has been made to describe the leading physical and climatic conditions and to show how these have helped to mould the history of the continent and to determine the directions in which material development has taken place. Numerous popular works have appeared dealing with South America as a whole or with the separate countries, and a number of scientific books has been written in English, French and German which give the results of detailed investigations of the relief, the structure, or the resources of one part or another of the continent. Scarcely any attempts, however, have hitherto been made to examine the whole continent systematically from the geographical standpoint.

With regard to the basis of subdivision for the purpose of detailed treatment, there is a choice between that by countries and that by geographical regions. From the purely economic standpoint there is much to be said for the former, since political boundaries affect the lines of modern communications and transport, and these together with tariffs have a distinct bearing upon economic development in different districts. On the other hand, there are weighty objections against treatment by countries in South America: the areas occupied by the various states are of very unequal size; international boundaries often cut across natural regions; and geographical and economic features that require to be viewed as parts of a single setting are consequently broken up among the various countries. On the whole, natural conditions have appeared more important than political factors, and freedom has accordingly been exercised in subdividing the continent into separate regions, so as best to serve the double purpose of securing fairly homogeneous physical areas and of presenting outstanding resources and industries in as complete a form as possible for the whole areas in which they are prominent. It is hoped that readers will gain clear pictures not only of the separate parts, but also of their relations to the rest of South America, and, as regard certain of their industries, to the world at large.

Care has been taken to collect the most reliable and up-to-date material from all available sources. For this purpose a great number of books, papers, maps and reports published in Great Britain and abroad has been consulted. A list containing the more useful of these is given in the bibliography at the end of this book. Where discrepancies have been observed in the material obtained from different sources, care has been taken to check, if possible, from further authorities, or failing that, to accept only the more reliable. Gaps are still unfortunately not uncommon in the published works on South America, but these are being gradually filled, partly by work done by South Americans, more especially, however, by means of investigations conducted in various parts of the continent by explorers and travellers of British, American and German nationalities among others. Much valuable information relating to various departments of the economic life of South America has been and is being collected by the consular services of the great commercial nations, and by the large Public Utility enterprises, mainly of British origin, of long standing in such countries as Argentina, Brazil and Chile.

The writer of a geographical work on South America or on any part of it, unless he is setting forth the results of his own personal observations, has a more difficult task than the historian who treats of what has happened there. The Spanish and the Portuguese, both in Europe and in the New World, have been more interested in describing characters and events than in studying the physical milieu and its influence upon human activities. Individual authors and learned societies in the Iberian Peninsula and in South America have had a great deal to say about what people did and said but are mainly silent about places.

In the preparation of some of the maps and diagrams I have utilized material already published. I have acknowledged the debt wherever it appeared necessary, but take this opportunity of indicating the source and my indebtedness more specifically in certain instances. Fig. 9 has been specially constructed from data given in H. Morize's "*Contribuição ao Estudo do Clima do Brasil*" (Rio de Janeiro, 1922), and B. Franze's "*Eine Karte des Temperaturverlaufs in Südamerika*" (Petermann's Mitteilungen 1929, Hefte 3-4, and 5-6). Fig. 12 is based largely upon a map in Zon and Sparhawk's "*Forest Resources of the World*," to use which the McGraw-Hill Book Company of New York have kindly accorded permission. The rainfall map of North-East Brazil (Fig. 21) is based upon one in a recent report of the Brazilian Inspectoria Federal de Obras Contra as Secas. The rainfall map of Chile (Fig. 47) is reproduced from Mark Jefferson's "*Rainfall of Chile*," by kind permission of

the American Geographical Society; and the map of the Chilean Nitrate fields is taken from that which appears in Trade Information Bulletin, No. 170, of the United States Department of Commerce.

E. W. SHANAHAN

LONDON

JANUARY, 1927

PREFACE TO SECOND EDITION

IN preparing this book for the second edition, every material fact or conclusion has been carefully reviewed, and some modifications and corrections have been made. The statistical matter has throughout, wherever possible, been brought up to the latest date for which reliable figures are available, mostly to within the last year or so.

The latter half of Chapter II has been recast, so as to give an account of temperature and other factors in the climate. The additional text is the result of much sifting and condensation of material from a number of the latest sources, chiefly foreign. In connection with this, four isotherm maps (Fig. 9) have been specially constructed from data but recently available, covering observations for 10-year periods in most instances, at some 70 stations in South America. These maps differ in some important particulars from the majority of those hitherto published, but the data are now sufficiently numerous and complete to give these maps, it is hoped, reasonable reliability.

E. W. SHANAHAN

LONDON

NOVEMBER, 1929

PREFACE TO THIRD EDITION

THE book has been revised throughout for this further edition. Figures relating to production, trade and similar matters have in most cases been brought down to 1930 or later, though a few of those for earlier years have had to stand in the absence of more advanced reliable information. The maps of Figs. 22, 23, 24 and 25 have been redrawn so as to incorporate more recent data.

E. W. SHANAHAN

LONDON

JANUARY, 1934

PREFACE TO SIXTH EDITION

IN revising this book for a war-time edition some minor alterations and additions have been made, chiefly in order to bring the matter into line with changes in South American industry and trade since 1930, as far as this has been possible under the difficulties of the present time. The Frontispiece and Fig. 18 have been re-drawn.

E. W. SHANAHAN

TORQUAY

JUNE, 1944

PREFACE TO SEVENTH EDITION

IN this edition statistical and other factual material has been revised throughout with a view to presenting a correct account of conditions towards and after the close of the second Great War. Special attention has been given to the growth of manufactures and to the developments in transport in their bearing upon changes in the national economies. A map showing air services in operation in 1946 has been added on p. 62A.

E. W. SHANAHAN

LONDON

SEPTEMBER, 1947

PREFACE TO NINTH EDITION

DEVELOPMENTS and changes in progress in most of the South American Republics prior to 1945 have since proceeded with increased momentum. Though the physical environment has remained as it was, the human adjustment to it, at all events in the sphere of economic activity, has become more alert and dynamic in the last decade than for centuries past. This has come about largely through improvements in transport, especially by air services, which have strengthened the controlling powers of the central governments in implementing vigorous policies of economic nationalism.

In revising this book an attempt has been made to indicate some of the salient features of the changing economic scene, in particular by bringing statistical and factual matter as far as possible into line with the position at the close of 1950, and by suggesting trends where they can be detected.

E. W. SHANAHAN

PREFACE TO TENTH EDITION

THIS book has been fully revised in the light of recent developments, and of the relevant statistical data, available from general and from official South American sources up to 1955 or 1956 in many instances. Some of the maps have been substituted by others more complete in detail or more suitable to illustrate particular geographical distributions. Except here and there on the maps, the older forms of a number of Brazilian place names have been replaced by those now in use.

LONDON

OCTOBER, 1958

E. W. SHANAHAN

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CHAPTER I

THE PHYSICAL FRAMEWORK OF THE CONTINENT

Position

THE north-eastern angle of South America, projecting towards Western Africa, serves to divide the Atlantic Ocean into two well-marked basins, the northern and the southern. It so happens that Cape S. Roque, a prominent landmark on the coast of this angle, lies less than 6° S. of the Equator, and the nearest point to it in Africa, about the same distance north of the Equator. The shortest line between Cape S. Roque and the African coast can be conveniently taken as that which separates the North from the South Atlantic, since it intersects the Equator at a small angle and leaves almost equal, but very small portions, of either Atlantic basin in the opposite hemisphere to that by which it is known. Compared with the average breadth of both the North and the South Atlantic, which exceeds 4,000 miles, the passage, some 1,800 miles in width between North-Eastern South America and Western Africa, uniting those ocean basins, is relatively narrow. In this middle section, not only does the New World reach out closer to the Old than anywhere else except in the extreme northern and stormy zone, but it lies directly on the extension of the route from the south-western corner of Europe past Cape Blanco on the western coast of Africa. In fact, the north-east and south-west line which forms the generalized boundary of the North Atlantic against Europe and Africa, when continued across the Equator, almost follows the east coast of South America and so marks the western boundary of the South Atlantic.

Even if it did not drain almost entirely to the Atlantic, South America would be tributary to that ocean rather than to the Pacific, since its north-eastern coast, forming the southern border of the North Atlantic, faces Western Europe and Eastern North America; while its eastern coast along the South Atlantic is

easily reached, as already seen, from the western part of the Old World; indeed, the ports on the northern section of that coast are nearer to South-Western Europe than they are to the populous parts of North America. To what extent South America belongs to the Atlantic can be appreciated from the fact that the meridian of New York cuts the southern continent so as to leave almost the whole of it on the side of the Old World. South America eastward from the Andes can, in short, be regarded as a broad wedge driven far into the Atlantic. Or, if the Panama Canal be taken as a channel connecting the two great oceans, then South America assumes the form of an enormous island lying entirely east of the medial line of Eastern North America.

The situation of South America with reference to latitude resembles that of Africa more than of any other continent; but, while more than half of Africa lies north of the Equator, much the larger part of South America is in the Southern Hemisphere. There are further points of difference between these continents with respect to situation in latitude which incidentally cause a marked differentiation in climate and are best described by reference to features under that head: firstly, while only about one-half of Africa lies between the northern and the southern tropic, a considerably larger part of South America, amounting to about two-thirds of the whole area, is within the same limits; secondly, Northern Africa reaches just inside the Mediterranean region of winter westerly winds and leaves an area of the maximum breadth in latitude, within the zone of the northern trade wind deserts, while the northern part of South America extends but little beyond the belt of equatorial calms, and only so far into the trade wind belt, and with such a relatively narrow projection, as to be secure against any marked permanent aridity even when mountain ranges line the windward coast; thirdly, the southern corner of Africa in latitude 35° S. is just within reach of the westerly system in winter only, whereas, since South America extends as far as 56° S., the southern portion of it, which occupies somewhat more than a third of its total length, is under the influence of the same winds in winter, and of this a part which occupies about a quarter of the length of the entire continent, is so at all seasons of the year.

Relief and Coastline

In every area, the general relief, and especially the arrangement of the highlands, is of the utmost importance in the study of its geography, since the directions assumed by human activities depend intimately upon this factor. Of still greater importance,

however, because of the effects upon climate, is the disposition of mountains and uplands with reference to distance from, and alignment as to, the coastlines, and in particular with reference to the great belts of planetary winds. These effects, as evidenced in South America, will be discussed in detail in the following chapter; here the chief interest lies in the relationship between the major topographical features and the structure of the continent as a whole.

The roughly triangular shape of the continent is determined by the position of four main highland masses; each of its three coasts following at no great distance, and for long stretches nearly synchronizing with, the 600-foot contour. The Pacific coast lies throughout about 100 miles distant from the crest of the Western Cordillera, but is in reality more intimately related to the line of the Coastal Range which, though weak in the north, completely broken up in the south, and scarcely discernible in Central Peru, rises steeply from the shore for over 1,500 miles in Chile. The northern and north-eastern coast of the continent follows the line marked out, first, by the terminations of the Northern Andes, then by the course of the North-Eastern Cordillera in Venezuela, next by the Guiana highland block beyond the Orinoco, and finally by the north-eastern edge of the Brazilian Plateau. The east coast follows for more than half its length the Atlantic scarp of the same plateau, and southward beyond the Rio de la Plata, the sinuosities of the eastern edge of the Patagonian Plateau. These connections between the position of the highlands and the coastal outline are illustrated in Fig. 1.

Of special interest with reference to the nature of the coastal hinterlands is the position of the main axis of the highlands and the general direction or directions in which they slope. As a rule in South America, along the whole of the west coast, the greater part of the east coast and along Central Venezuela in the north, lines of maximum elevation are encountered at no great distance from the sea; from these lines the land slopes away from the coast towards the interior (Fig. 1).

In this connection the northern coast of the continent, with the exception of the Central Venezuelan section, affords a striking contrast to almost all the rest of it. In Colombia and Western Venezuela two great ranges of the Andes and a limb of the third range strike towards the coast more or less at right angles, leaving valleys or depressions between them which afford access far into the interior. In the Guiana region both of Venezuela and of the European colonies, the main axis of the massif lies well to the south so that the scarp-like edge is towards the Amazonian interior lowlands, and the long and gentler slope towards the

coast. Finally, in North-Eastern Brazil the plateau falls somewhat gradually towards the North Atlantic, and river valleys in the course of the ages have produced the appearance of a grain in its structure in that direction. Here, also, it is possible to penetrate a long distance inland in a general south-westerly direction before any distinct continental watershed is apparent.

The Patagonian region of the east coast of South America also furnishes a contrast which, however, is more apparent than real, to the prevailing position of highland axes in the continent with reference to the coastlines. The Patagonian Plateau slopes gently towards the Atlantic from its western rim near the Andes, and the drainage, mainly of Andean origin consequent upon extensive infilling of the pre-Cordilleran trough, is accordingly eastward. The plateau formation, however, continues right to the Atlantic, except in Rio Negro Province¹, so that a steep ascent is generally necessary to gain its surface on approaching it from the coast. Inland, the plateau, though exceedingly broken and uneven in places, is uniformly high, except where it is intersected by the deep grooves cut east and west across it by the few rivers which, without tributary valleys except quite near the Andes, carry water deposited on those mountains right across it. Were it not for thick deposits of lava and detrital material on the surface of the plateau towards the west, its western edge towards the Andes would not stand very much higher than its eastern edge towards the Atlantic.

Relief and Drainage

The position of the main highland ridges close to, or not far removed from the coasts throughout at least three-quarters of the shorelines of South America, causes it, to a more striking degree than any other continent, to drain in the first instance towards the interior. These inward-flowing streams unite later for the most part in three or four great waterways, through which they discharge ultimately into the Atlantic. Owing partly to this concentration of drainage in the interior lowland plains and partly also to the heavy, and for the most part, seasonal rainfall experienced in them, large areas of the continent are subject to periodic floods, or more or less permanent water-logged conditions. In this feature there is a marked resemblance between South America and Ireland where, though everything is naturally on a much smaller scale and the upland axes are proportionately further removed from the coasts, there is the same tendency towards concentration of inland drainage into a combined waterway flowing through a water-logged plain, just as occurs in the basins

of the Amazon, the Paraná-Paraguay, and even the Orinoco. Except when rapids and falls occur near the mouths of such great streams, the latter are eminently serviceable for inland navigation, and particularly so if the average fall in the bed of the river is small, as it is in those of the great rivers of South America. The Amazon has a fall of less than $2\frac{1}{2}$ inches per mile in the 2,000 miles of its course from Iquitos to the sea, and is thus far the most notable navigable river in the world. The Paraguay-Paraná from Corumbá to the La Plata Estuary likewise has but a gentle fall and is navigable for small craft for at least 1,500 miles. The Orinoco, however, differs from the two larger waterways of the continent in that rapids occur some 600 miles upstream and divide navigation on the river into upper and lower sections, but this river resembles the others mentioned, inasmuch as the fall between the Casiquiare Channel and the rapids and again between the rapids and the sea, is very small indeed. The fourth leading drainage channel of South America, namely the São Francisco River of Brazil, is a plateau river which receives only a limited number of streams flowing westwards and inland before emptying themselves into it. Like that of the Orinoco, its course is broken by rapids, which, however, owing to the fact that they are situated near the sea at the place where the river descends from the plateau, terminate in an enormous cataract; but above this sharp descent the river has little fall in the next 800 miles, and is navigable nearly to its source.

A closer examination of the disposition of the eastern highlands reveals the fact that between one and another there are only narrow passages whereby the drainage of upwards of two-thirds of the whole continent escapes to the sea. The result is that immense flagon-shaped areas of lowland and moderate upland have come into existence whose narrow tongues reaching to the sea are traversed lengthwise by great rivers draining enormously wider areas behind these defiles.

The Amazon and the Orinoco both flow through narrow passages, in each case not more than 150 miles wide, shortly before entering the sea. The Rio de la Plata system is confined in its estuary section to a space of lowland of about 200 miles in width between the crystalline rocks of the Uruguayan continuation of the Brazilian Plateau and similar rocks in the Tandil Sierra in the central part of Buenos Aires Province. A similar feature is observable in the Maracaibo area of Colombia and Venezuela, where a lowland area, occupied in part by a brackish lake, discharges its drainage into the sea through a bottle-neck little more than a third in width of the inland depression. The peculiar shape of Lake Maracaibo with its narrow outlet is itself

but is a replica in miniature of the basins of the Amazon, of the Paraná system, and of the Orinoco.

This disposition of the major relief features whereby the highlands not only stand in relatively close formation, but tend to throw their drainage away from the coast into the broad interior basins, causes the continent to be remarkable for the fewness and size of its independent rivers. In the Amazon and Paraná-Paraguay Basins this form of concentration has been pushed to further limits than are to be found anywhere else, with the result that in respect of the volume of water carried to the sea the Amazon and the Paraná are among the largest rivers in the world. Independent rivers of any size have but little chance of coming into existence when the coasts throughout the well-watered parts of the continent are almost everywhere guarded by mountains and plateaus whose high crests overlook the sea, and thus force the bulk of the drainage to find its ultimate outlet only at a few well-marked gaps where the relief falls to sea-level. In recent geological times, indeed, it appears that the Amazon continued its course some four or five hundred miles farther east than it does now, and probably numbered the Parnahyba and other now independent rivers of Northern Brazil among its tributaries.

From the standpoint of geological time the three great rivers of South America, as they now exist, are of quite recent origin, while the São Francisco is probably extremely old. In early Tertiary times the continent was apparently considerably larger than it is at present, but subsidence afterwards occurred which allowed the sea to encroach upon the plains of the Amazon, the Orinoco, and probably also of the lower Paraná. The great period of uplift in the Andean region which followed marks the beginning of the development of those three rivers into the great systems of the present day. Vast quantities of alluvium were brought down by the parent streams from the rising Andes and spread out in huge fans eastward until they met and joined with similar fans brought down from the Guiana and Brazilian plateaus by other streams, which thereupon became tributaries to the main ones. The sea was thus gradually pushed out until the shoreline lay somewhat east of its present position at the mouth of these rivers. Recent subsidence, combined with the continual discharge of enormous quantities of sediment, has given rise to the mixed estuary and delta at the mouth of the Amazon and the shallow estuary strewn with sandbanks at the outlet of the Paraná and Uruguay. Should the recent subsidence continue, the whole process would be reversed. A downward movement of some 300 feet only would bring the sea back near the foot of the

Colombian Andes in the Orinoco Valley and to the foot of the Peruvian Andes in that of the Amazon, and would enable it to penetrate so far northwards into the Chaco region in the Paraná Basin as completely to sever the Paraguay River from the main stream.

Drainage towards lower points inland is a feature which is not confined to the eastern and northern parts of South America. The Andes, by reason of the high parallel chains which continue for the most part unbroken along the eastern and the western rims of their interior plateaux for a great distance from north of the Equator to the Tropic of Capricorn, contain two large and a number of smaller enclosed basins. The scanty snowfall deposited on the eastern slopes of the Pacific Cordillera, descends on melting into these basins, which also receive any drainage available from the melting of snows on the western face of the opposite chains, but which owing to the general aridity, seldom, except towards the Equator, have outlets occupied by permanent streams. The two larger basins of inland drainage referred to are found in the middle section of the Andes where the precipitation on the heights is small and where also there is a maximum distance between the eastern and the western chains. Farther north the tendency towards the formation of extensive basins of this type has been greatly reduced, partly by the fact that the various parallel chains stand much closer together, partly because the heavier precipitation of the eastern chains has led to the cutting of outlets from the inter-Andean valleys and basins to the Amazon drainage system.

The Structure of the Continent

South America, broadly speaking, consists of a great system of folded mountains in the west and north-west, together with three plateaus in the east arranged so as to form a large shallow curve, concave towards the folded system and almost touching it in the north and south. Between each of the plateaus and the next and also between them all and the western mountains there are tracts of detrital deposits which in the central and northern parts of the continent are very extensive. In this respect the western part of South America stands in marked contrast to the eastern; for on the Pacific slope coastal plains are entirely absent throughout the greater part of its length, and where they exist, as in Peru and Ecuador, they are everywhere narrow.

The explanation of this striking feature is to be found largely in the extensive trough faulting on the Pacific shore which accompanied the upward movement of the Andes and of the Coastal Range, and which has caused the descent on the west

to deep oceanic waters to be as a rule very steep. The recent elevation of the coast in Peru and farther south has been of little avail to extend the coastline westwards in these circumstances. It is true that the quantities of sediment brought down from the Andes throughout the whole central western arid region have been quite small, and consequently little building up of new land has been possible on the shore-lines there, but even where, as in the northern and southern sections of the Andes, denudation westwards has been heavy, the coastal plains are very narrow or non-existent.

On the eastern slopes of the Andes and of their subsidiary chains, denudation has almost everywhere been extraordinarily heavy, as also on the Brazilian and Guiana Plateaus, so that there have been sufficient supplies of sediment not only to fill up the great corridor running north and south between the plateaus and the Andes, but also the three smaller east and west ones between the plateaus and between the Guiana block and the Venezuelan Andes. In one respect the eastern margins of the continent resemble the western: except in the Pampa region of Argentina the coastal plain is narrow from Cape S. Roque to the Straits of Magellan and practically disappears in Central and Southern Brazil. Here subsidence, as evidenced by the numerous rock-basin harbours of Brazil and the estuaries at the mouths of the main rivers, has caused the sea to invade a previously existing coastal plain and to bring the present shore close up to the eastern scarps and edges of the two southern plateaus. Along the northern coast, however, from the outlet of the Amazon to the Isthmus of Panama, the slope of the dry land to the sea and of the floor of the sea itself is generally gentle, while at the same time the region is nowhere close to great oceanic depths. Thus the coastal plains become more pronounced, the Orinoco and the Magdalena Rivers have been able to build up deltas, and this and other features furnish evidence of the land gaining at present on the sea, after a period of subsidence which caused Trinidad and other islands off the Venezuelan coast to be separated from the mainland.

THE WESTERN MOUNTAINS

The western folded mountains comprise not only the Cordilleras proper of the main Andes, but also the Chilean Coastal Range, the Pampa Ranges in Argentina, and a somewhat tangled mass known as the Pre-Cordilleras in the north-western and western parts of the same country.

The Coastal Range of Chile extends along the whole length of the country, and in the extreme south it continues beyond the

Chilean frontier into Argentine territory in Tierra del Fuego. It attains a maximum height of nearly 8,000 feet in latitude 25° S., with an average elevation in its central and northern sections of 3,000 to 4,000 feet. It falls toward the northern frontier of Chile, beyond which, in Peru, it is recognizable only in the form of a few isolated blocks; and it falls again towards the south, where extensive glacial and river erosion combined with subsidence have broken it up into a chain of islands. On the mainland from Valparaiso southwards the chain consists rather of a series of separate heights than of a continuous ridge, such as is found in its more elevated central and northern portions. Northwards from Valparaiso, in fact, it is intersected by few river valleys, and few as these are, they diminish in number as the arid region is approached, where they are altogether absent for hundreds of miles. Throughout almost the whole of these higher central and northern sections, steep and almost precipitous ascents are necessary to surmount the chain from the shore, so that there it offers purely physical obstacles to communication with the interior comparable with those presented by the eastern face of the Brazilian Plateau.

Between the Coastal Range and the Western Andes in Chile lies the Longitudinal Valley, frequently intersected, at all events in the central part, by spurs of the Andes; but it can, nevertheless, be traced all the way from Tacna Province in the extreme north to the Gulf of Ancud opposite Chiloe Island in the south, and even beyond, though flooded by the sea, behind the string of outlying islands that fringes the coast down to the Straits of Magellan. The floor of the Longitudinal Valley is covered extensively by sediments brought down from the Andes which are deepest towards the eastern margin of the valley, where they tend to be piled up in a succession of talus fans. These are more noticeable in the north, where permanent streams are very rare and have little power of carrying sediment, than in the south, where a number of considerable rivers sweep across the valley and through gaps carved by them in the Coastal Range, into the Pacific.

None of these rivers, however, form estuaries of a type suitable as modern harbours; and farther north, where denudation has been at a minimum and recent elevation has been in evidence, facilities for shipping are still worse. The abrupt rise of the Coastal Range from the shore which varies but little from a continuous straight line, is highly unfavourable to the existence of sheltered bays or openings. Absence of indentations is indeed a marked feature of the western coast of South America, all the way along the North Chilean and Peruvian coast, where recent

elevation has had the effect of effacing any previously existing erosion features on the shore. Thus terrestrial movements have combined with peculiar topographical and climatic conditions to make almost the whole of the inhabited part of the western shores of the continent singularly devoid of good approaches for sea-borne traffic.

On the Argentine side, the main chains of the Andes north of the latitude of Córdoba are bordered by the Pampa Sierras and the Pre-Cordilleran Ranges. In contrast with the Pacific Coastal Range, these are related to the Brazilian Massif, of which they apparently formed the western margin in early geological times prior to the fracturing and subsidence of the Massif in the area of the Chaco-Pampa basin. Their present forms, however, are mainly the result of block upthrusts associated with the Tertiary elevation of the Andes and the Puna, with which the Pre-Cordilleran Ranges are now closely knit northwards into a complex mountain system.

The axes of all these chains lie either parallel with, or inclined at only a small angle to that of the Andes ; but whereas the Pampa Sierras in Córdoba and S. Luis are separated from them by a relatively wide space in which the connecting bridge is generally less than 3,000 feet in height, the Pre-Cordilleran Ranges mostly become continuous with the Andes and the Puna towards their northern parts, and are divided one from another by a series of deep tectonic valleys, opening southwards as the ranges diverge slightly from the main Cordilleran zone. This system accordingly shows the most concentrated corrugation where it springs from the main Andes in the north, and it gradually expands and weakens toward the south as it escapes from the influence of the Brazilian block. The whole system is thus broadest in the southern section between latitudes 30° and 35° S., where, if the Pampa Ranges are included, it attains a maximum width of some 350 miles. Since its eastern edge lies roughly north and south, it tapers considerably towards Northern Argentina in proportion as the Eastern Cordillera diverges from the Western to enclose the Puna de Atacama, until in Jujuy the Pre-Cordilleras are little more than 100 miles in width and finally disappear somewhat beyond the Bolivian frontier. Towards the central and northern parts of the system, where cross-fractures are frequent and where occasional heavy summer rains and snows are brought by the south-east trades, there gaining in force, the tectonic valleys mentioned are supplemented by complicated systems of tributary valleys and ravines which penetrate both the Pre-Cordilleras to the east and the lofty Andes to the west.

The Andean Cordilleras,¹ so named because of their almost straight alignment parallel with the west coast, have only recently been elevated to their present height, and the last phase of that elevation, namely the piling up of huge quantities of volcanic debris in various parts of the eastern and western chains is only now drawing to a close. The system attains its maximum average height and also its greatest breadth in the central section between latitude 15° S. and the Tropic of Capricorn. South of Aconcagua the Andes begin to sink gradually, and from the 40th parallel to Tierra del Fuego have been deeply eroded by glaciers, so that in this region there are numerous low passes across the chain, while between the southern terminus of the Andes and the south-eastward curve of the Coastal Range in Tierra del Fuego is the sea passage of the Straits of Magellan. In their northern section the Andes also diminish in general height after splitting up in Colombia, and the comparatively low eastern limb finally gets breached in its turn by the sea between Trinidad and the mainland.

It is noteworthy that the Central American chain which enters South America from the Isthmus of Panama is structurally distinct from the Andes, and is recognizable but a short distance down the west coast of Colombia. Separating the Atrato and S. Juan Rivers, which flow respectively north and south between the Andes and the continuation of the Central American chain, there is a low divide of 450 feet in height, which represents the maximum existing elevation in the bridge between the two mountain systems.

Though continuing in nearly straight lines for immense distances in those parts of their course where they are a vigorous system, the Andes curve noticeably in a direction north-east and east from the point where they begin to weaken towards their northern extremity. A submerged branch of the eastern limb which traverses Northern Venezuela can be traced running parallel with it in the string of islands along the coast of that country. There is indeed reason to suppose that this branch formed at one time a chain continuous with the submarine ridge upon which stand the Windward and Leeward Islands of the West Indian

¹ In Spanish-speaking South America the name Cordillera is applied to the Coastal Range as well as to the great ranges of the Andes. It is convenient, however, to limit the term to the latter, the various sections of which bear additional distinctive names. Of the two main border ranges between 28° S. and Southern Peru, the Western Cordillera or Cordillera Occidental is known also as the Maritime or Pacific Cordillera, and the Eastern Cordillera as the Cordillera Oriental or Real. The various names applied to the chains in the Northern Andes do not require further explanation.

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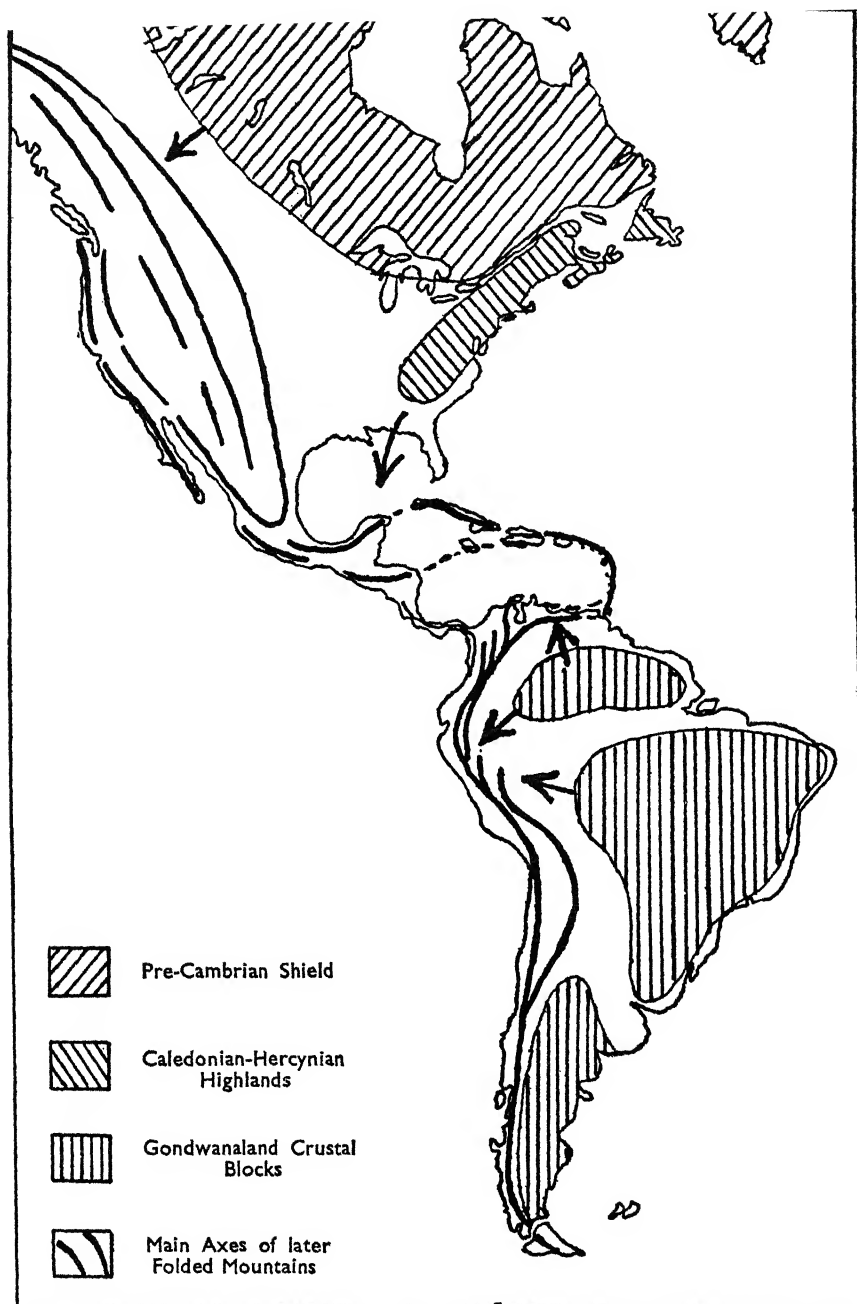


FIG. 2.—North and South America : showing arrangement of the western folded mountains in relation to the old crustal blocks

group. The broad curves and the east and west lines, so prominent in Northern South America and in the Caribbean region, point to an eastward spread, in a characteristically distorted form, of folds related to those of the main Andean system, in that region where resistance was at a minimum between the Laurentian-Appalachian block of North America and the Guiana-Brazilian block of South America. For a diagrammatic representation of these developments, see Fig. 2. The marked curves of the Andes from the Equator northwards bear a striking resemblance to those of the Alpine system in Southern Europe and Northern Africa, and are due to an analogous disposition of resistant blocks.

In the extreme south of the continent the Chilean Coastal Range, on passing beyond the Patagonian Plateau and that of the Southern Andes, also makes an eastward curve, which, however, ends at Staaten Island. For the Falkland Islands, though connected with the mainland by a submarine bank, differ in geological structure from the southern part of the western folded mountains, and are to be related to more easterly elements in the continent.

The northern wing of the Andes reaches eastward nearly to the 60th meridian in Trinidad, and the eastern wing of the Coastal Range in the south to the 65th. The line connecting these two easternmost points of the western folded system divides the continent into two unequal parts of which the smaller lies to the east. The folded mountain system thus enfolds on three sides a large section of the continental lowland, including the whole of the Orinoco plains and the greater part of those of the Amazon, both of which areas lie between the north-eastern limb and the eastern foothills of the Bolivian Andes.

THE EASTERN HIGHLANDS

The basic formation in each of the three eastern plateaus in South America consists of ancient and extremely hard crystalline rocks, but in all of them these rocks are partially overlaid by sediments of varying age from Devonian in certain parts of Brazil to quite recent fluvio-glacial and eolian in Patagonia. In contrast with those of the western chains the rocks in these plateaus have long remained undisturbed by terrestrial movements; and except in Patagonia manifestations of Tertiary and Recent volcanic activity are almost entirely absent.

In spite of the fact that the Brazilian and Guiana plateaus appear to die out some distance east of the Andes, their roots continue westward to the foot of those mountains and are encountered in the beds of the streams that descend eastward

towards the Amazon and the Orinoco. The Patagonian plateau lies so far west that its edge is separated from the Andes only by a narrow trough. The Brazilian plateau is similar in rock structure to that facing it in Africa across the narrow middle-Atlantic passage described early in this chapter, and was probably connected with it at some remote age. Whether, as recent theories of geomorphology would seem to postulate, the eastern South American plateaus have become detached from the African block and migrated westwards, thus forming a displaced continental margin in which the Andean folded chains were subsequently elevated ; or whether they have remained in situ, and have become separated from the Old World by the breakdown of an Africo-American land bridge, is not as yet clear. One thing, however, is fairly evident, namely, that the western folded mountains turn north-west in Bolivia in response to the resistance offered to their continued northerly course by the deep-seated western sections of the Guiana and Brazilian blocks ; and that they turn almost due east in both the north and the south when they escape, in the former direction from the Guiana massif, and in the latter from the Patagonian plateau.

CHAPTER II

GENERAL CLIMATIC CONDITIONS

A. Rainfall

NO survey, however cursory, of the climatic characteristics of any region is of practical value unless it takes account of the seasonal distribution, as well as of the yearly total, of whatever precipitation occurs in it. In view of the predominance of agriculture in one or other of its forms among the industries in all South American countries, even those rich in minerals, special emphasis requires to be given to seasonal fluctuations in rainfall in discussing the climatic phenomena of the continent.¹ But here there is the difficulty of insufficient data. The number of meteorological stations is few in proportion to the vast area, and a number of those actually in existence have been working too short a time to give trustworthy annual, to say nothing of seasonal, averages. Rainfall maps for even the more fully settled parts of South America have accordingly to be revised from time to time, to bring them more nearly into accordance with the facts as revealed by the records of more effective weather services. The outstanding facts of climate are known, however, in a general sort of way for the coastal zones right round the continent and for some of the economically more important inland regions as well, and with this material it is possible to frame a working account of the rainfall and other climatic conditions in almost all the more populous parts of South America, and to get a rough idea of the same conditions in the rest.

The continent as a whole falls into a number of well-marked climatic regions whose boundaries are determined as in other continents, mainly by the position of the great belts of planetary winds in conjunction with the position, the height and the direction of the chief highland axes. These South American climatic regions stand out as a rule with singular clearness, and

¹ From the agricultural standpoint there are further important factors to be considered in connection with the rainfall, e.g. whether it occurs in a few violent downpours or is evenly spread throughout the season or the year, and again, whether the run-off is rapid or comparatively slow. These and similar factors are dealt with in the detailed accounts below of the various parts of the continent.

the major determining factors for each are not difficult to assign. One of them, however, that comprising the arid region of North-Eastern Brazil, is not easy to explain and its climate presents problems for which the complete solution is yet to be found.

Since the high wall of the Andes lies across the track of both the trade winds and the westerlies, there tends to be a marked differentiation in the amount of the precipitation on opposite sides of the chain in any given latitude. This holds for the whole of the continent from about 3° S. to the southern extremity, that is, for all zones except that north of the Gulf of Guayaquil.

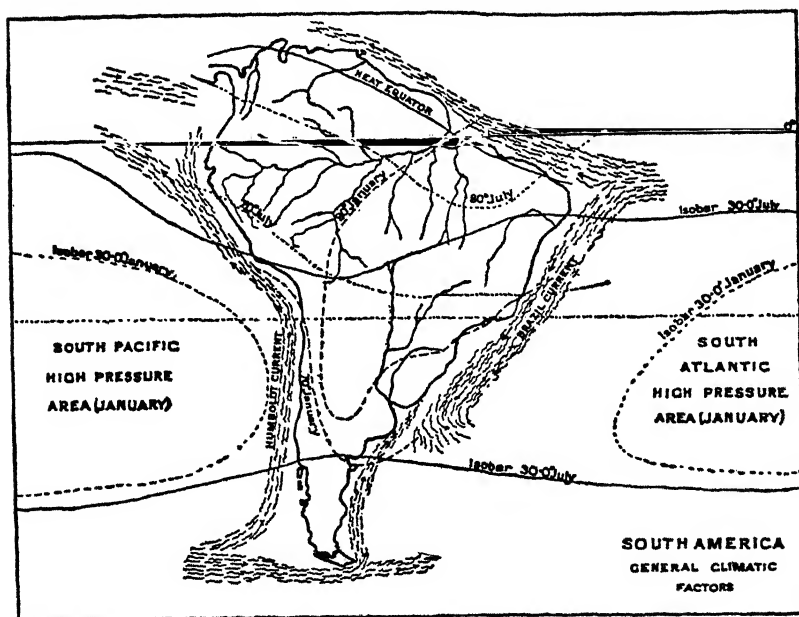


FIG. 3.—General Climatic Factors

This means that there are at least two types of rainfall, and consequently also of climate, east and west across the continent in both of the southern hemisphere wind-belts, and to a minor extent and for special reasons, also in that part of the belt of calms that lies immediately south of the Equator.

The fundamental factors in the distribution of the rainfall of South America are three in number: first, the permanent areas of high pressure over the South Atlantic and the South Pacific between the 20th and 40th parallels; second, the equatorial-continental region of low pressure in Upper Amazonia, moving with the sun so that it is mainly north of the Equator

in the northern summer and mainly south of it in the southern summer ; and third, the vigorous ocean currents which skirt the shores of the continent—the warm equatorial current that splits at the north-east corner, and so washes both the eastern coasts, and the cold Humboldt or Peruvian current which flows close inshore all the way from Southern Chile to Northern Peru.

The first and the second of the above factors are mainly responsible for the variations in the directions and force of the winds from what would be expected in accordance with the generalized theory of planetary circulation. The ocean currents profoundly affect the relative humidity of the air which reaches the shores from the sea, and, in conjunction with the source and direction of the prevailing winds, cause the thermal equator in the continent to lie approximately along the line from Panama to Cape S. Roque at an angle of nearly 15° from the true Equator.

In studying the climatic conditions of a continent such as South America so much of which is subject to the trade winds, it is important to note that these winds are not necessarily carriers of moisture. If they originate from high pressure areas extending over wide ocean spaces to the neighbourhood of the shores, the winds on reaching the land will be dry and will tend rather to absorb than to deposit moisture. Striking examples of this are observable in South America. Thus on the east coast from Bahia to Cape Frio, easterly winds during the southern winter are associated with fine weather, and again when the easterly winds increase in force in July in the region of the lower Amazon and the belt of tropical calms retreats inland, a relatively dry season sets in over the parts affected by the sea winds.

The seasonal distribution in South America is peculiar in that rain is confined mainly to the summer months both north and south of the Equator. To this generalization four regions, none large, provide exceptions. One of these is the Southern Brazil-Patagonian coastal zone (see Fig. 6). Another is a narrow equatorial zone extending lengthwise along the Upper Amazon Valley, between the Rio Negro and the Andes, in which the distinction between seasons is more or less lost and where rain falls heavily at all seasons of the year. The two others, the southern coastal region of Chile and the coastal area of North-Eastern Brazil, receive most of their rainfall in winter. The marked scantiness in general of precipitation during the winter months is due mainly to the fact that during the southern winter the high-pressure systems over the South Atlantic and over the South-Eastern Pacific both widen considerably so as to cover almost the whole belt between the Equator and 40° S.,

and at the same time extend towards each other and unite in a broad belt over South America; while in the northern winter the high-pressure belt of the northern hemisphere expands in a similar manner and advances south until it just reaches the Caribbean area, and so deprives the northern part of South America of any considerable rainfall during that period of the year.

The establishment of low-pressure systems in the interior of the continent appears to be the prime cause of the inward movement of the vast quantities of moisture which provide the heavy summer precipitation general everywhere in the tropical regions of the continent except along the arid west coast in the lee of the Andes and in the peculiar region of the north-east. Over the Equator, however, there is a moisture-laden upper current which moves west throughout the year over the Amazon Valley and which is largely responsible for the continual rains experienced in the upper half of the basin. When the sun moves south, this equatorial air is reinforced by vast quantities of moist trade wind air both from the north-east and from the south-east and a very wide area extending at least as far south as the Lower Paraná is then abundantly watered. When the sun moves north of the Equator, the southern margin of the Amazonian low-pressure system retreats to about 10° S., and the whole of the northern part of the Amazon Basin then comes under the influence of the equatorial calms, while the northern coastal slopes are at the same time well supplied with rains by the inflow of moisture-laden trade wind air from the Caribbean and from the North Atlantic beyond.

The South American summer rainfall thus bears a close resemblance to the monsoon type, but owing to the fact that the continent as a whole is warmer on the average for every season than the surrounding seas, there is no appreciable winter outflow of high-pressure air as there is from the interior of Asia.

Rainfall Regions

It is convenient to sub-divide South America into nine major climatic regions according to the amount and the seasonal distribution of the rainfall. These may be termed in order: I. The Northern Summer Rainfall Region. II. The Amazonian Region. III. The Semi-Arid North-Eastern Region. IV. The Interior Summer Rainfall Region. V. The Eastern Coastal All-Season Rainfall Region. VI. The Peruvian-Chilean-Patagonian Arid Region. VII. The Central Andean Sub-Arid Region. VIII. The Chilean Mediterranean Region. IX. The South Chilean Winter Rainfall Region. •

The approximate boundaries of these regions are indicated in Figs. 5 and 6. Fig. 5 shows the mean annual rainfall; Fig. 6 certain features in the seasonal distribution.

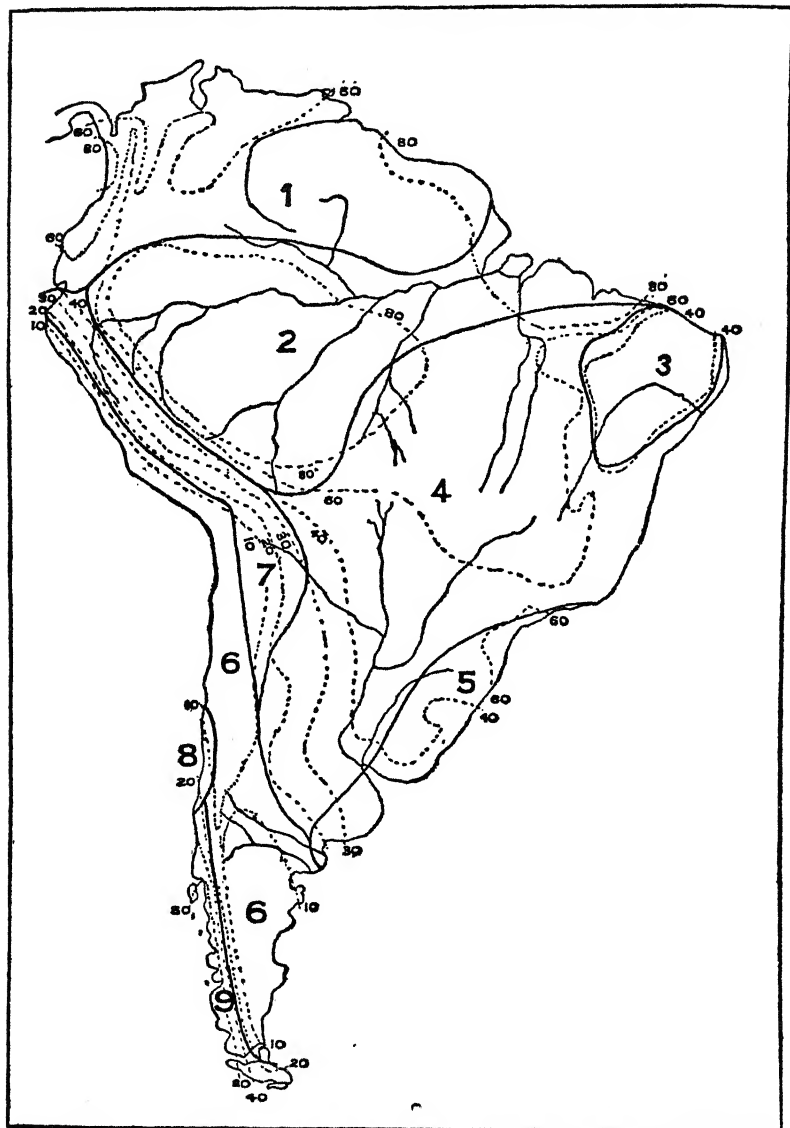


FIG. 5.—The Major Rainfall Regions of South America

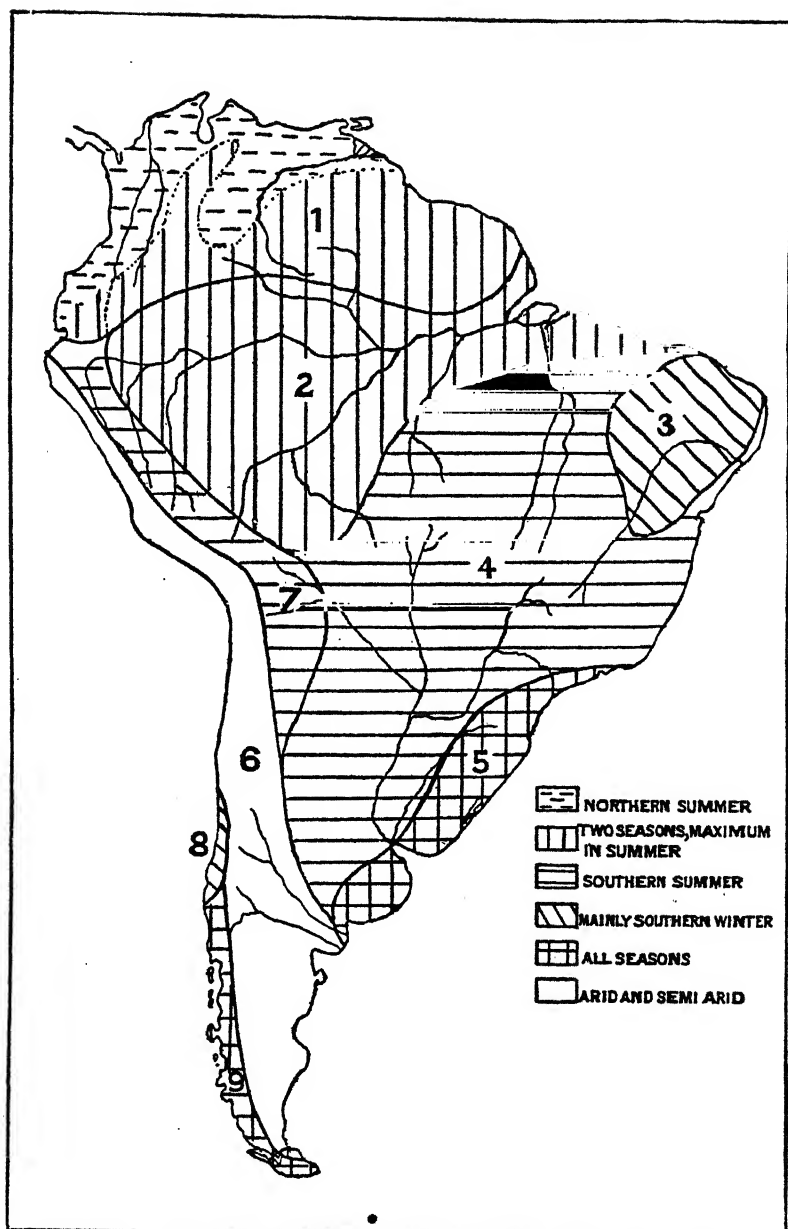


FIG. 6.—The Seasonal Distribution of Rainfall in the climatic regions of South

Some observations with causal explanations may now be made upon certain peculiarities in the distribution of the rainfall in these various regions.

Within the northern area (I), owing to the alternation of mountains and lowlands, the rainfall is by no means equally distributed. The winter drought that characterizes the region as a whole is most pronounced on the Orinoco Lowlands from above the delta to the western foothills, in the mountain-locked lowland in which lies Lake Maracaibo, and in the upper basins of the Rio Branco and other streams that drain south from the Guiana scarp towards the Negro and Amazon. On the other hand, the rainfall is heavier and more evenly distributed than elsewhere on the long slope of the Guiana Highlands towards the sea, and especially in the eastern part occupied by the European Colonies. The same feature is observed, as might be expected, on the exposed heights of the Northern Andes, and also on the Pacific coastal strip which receives rains not only during the northern summer when there is a strong inflow of moist air from the north-east, but again during the northern winter, when the continental low-pressure system immediately south of the Equator tends to pull in equatorial air from westerly and north-westerly points. In other words, the South-east Trade is deflected inshore here in July, and the North-east Trade in January. From north to south within the central section of this region there is a relatively rapid transition from the equatorial type of rainfall on the southern margin close to the Equator to the distinctly seasonal type in the lowlands of the Upper Orinoco. Compression in latitude of rainfall zones north of the Equator stands in sharp contrast with their extension in latitude south of it in the Madeira basin.

In Amazonia (II) there is considerable variation from place to place both in the amount of the rainfall and also in the manner in which it is distributed throughout the year. The following table gives the total annual rainfall in inches at various places in this region, and also the months in which most of it occurs.

	Rainfall.	Wettest Months.
Para (2° S.)	97·8	January–May
Obidos (2° S.)	62·0	February–May
Manaos (3° S.)	65·1	December–April
Iquitos (4° S.)	93·2	March–December
S. Felipe (7° S.)	105·9	October–April
Porto Velho (8½° S.)	98·4	October–April

During the remaining months of the year, i.e. those not given in the last column above, the rainfall is considerably lighter, but seldom fails altogether in any of them at any of the places mentioned.

It is sufficiently clear from the above table of annual rainfall that the Amazon region falls into two, if not three climatic subdivisions. In the extensive upper section adjoining the Andes, and reaching south behind the Brazilian Plateau into the upper part of the Madeira Basin and east to the middle course of the main river, there is a rainfall approaching 100 inches per annum, which, though heaviest in the southern summer months, is sufficient to provide no light fall throughout the rest of the year. This is therefore distinctly a region of the equatorial type of rainfall owing to the prevalence of tropical calms. The temperature is evenly high and the atmosphere almost always heavily charged with moisture.

From about Long. $62\frac{1}{2}^{\circ}$, where the Amazonian region begins to contract noticeably in width, to the estuary, the rainfall is only about two-thirds of that general in the upper basin and tends to become more seasonal in type. While the tropical calms prevail, as during the months from December to April, much rain falls; but during the southern winter strong easterly winds blow from the greatly enlarged South Atlantic high-pressure area, and the climate tends to be fresh and dry.

In the low-lying district at the mouth of the Amazon and for some distance from it in both directions along the coast, there is a relatively narrow strip whose inner margin assumes the form of a shallow curve, in which the annual rainfall is again distinctly heavy, approaching the 100-inch mark. Here, moreover, the distinction between the two yearly seasons is not so much that of wet and dry as that of very wet and moderately wet.

Although subdivisions are recognizable in the Amazonian region, the climate throughout is fairly uniform. No part of it is situated so far from the Equator as to be beyond the influence of the belt of tropical calms for more than a few months in each year. Thus the rainfall is everywhere heavy, as compared with the averages ruling in well-watered regions elsewhere; and is nowhere so concentrated into a few months to the exclusion of others as to be properly termed seasonal.

The semi-arid North-Eastern region (Figs. 6 and 21) is peculiar. In the southern summer, when the surrounding regions receive heavy rains, this north-eastern one is dry; the summer drought sets in, the trees lose their leaves and vegetative life comes to a standstill. Most of the rain that falls in this region comes with

the establishment of calms interspersed with storms during the winter when the rest of tropical South America south of the Amazon is relatively dry. The summer contrast is striking and is not easy to explain.

Recent investigations point to the fact that this region is linked closely with the Southern Hemisphere as regards the conditions of its rainfall.¹ Precipitation in the North-East is mainly in the form of thunderstorms produced by convection currents in the atmosphere which cause sudden condensation in strata apparently originating in Lower Amazonia to the west. The exact nature of these convection currents is not yet clearly understood; but it is at least clear that when the interior continental low-pressure system is unusually weak, the westward sweep of upper currents of air from the equatorial seas is diminished, and the air itself becomes more subjected to vertical currents against the resistant anticyclonic mass to the south, which cause more frequent storm-rains towards the coastal regions both in lower Amazonia and in North-Eastern Brazil.

During the southern winter this north-eastern region lies on the outer margin of the high-pressure area which extends from the South Atlantic across South America to the South Pacific. Its eastern part receives a certain amount of rainfall from the sea, while its northern part becomes in a weak way linked with the Amazonian area of calms. The interior of this region receives nearly all its rainfall in late summer, but the total amount that comes then is not appreciably greater than that in the surrounding regions which are better supplied with moisture during the rest of the year. The contrast between the late summer rainfall of the North-East and the relatively light fall in that season in the adjoining parts of the continent is almost entirely illusory. So uncertain is the seasonal rainfall in the interior of Ceará, that a whole year and sometimes even two or three years may pass without any appreciable relief from droughts. It appears also that the climatic conditions have become more severe during the most recent geological period; for there is evidence of areas having been formerly covered with vegetation of a type which is now confined to a few favoured districts.

A glance at the map, Fig. 6, shows how extensive is the area (IV) that receives rains, almost everywhere abundant, in the southern summer. It comprises some $2\frac{1}{2}$ million square miles and embraces a full third of the continent. In this respect South America is fortunate among the continents, and offers a striking contrast to Australia in particular, whose extension in latitude

¹ Cf. J. de S. Ferraz. *Causas Prováveis das Secas do Nordeste Brasileiro*. Rio de Janeiro, 1925.

corresponds to that of the southern half of South America. No other continent, in fact, Europe alone excepted, has so small a proportion of desert and consequently such a high average fertility.

Over the greater part of this summer rainfall region the annual precipitation amounts to at least 40 inches, and in a broad strip across Brazil on either side of a line drawn from Rio de Janeiro to Western Mato Grosso it rises to over 60 inches. From the continental watershed, which lies roughly along the line just mentioned, flow seven great rivers, one of which, the Paraná, is the third, if not the second river in the world in point of volume. Only in the south-western part of this region, in the inland section of the Argentine Pampa and the Western Chaco, does the rainfall sink to a figure that can be considered insufficient for agriculture. There the dry season every year is pronounced, and serious droughts occur when fluctuations in the rainfall cause it to be appreciably below the average.

Along the east coast of South America from Bahia in the north to beyond Bahia Blanca in the south, there is a zone which is well watered on the whole and which gets some rain at all seasons ; but the distribution of the rainfall by seasons varies from north to south in this region. For the northern part the percentages of the total annual rainfall in the different seasons have been given as follows : Summer $37\frac{1}{2}$, autumn $27\frac{1}{2}$, winter $12\frac{1}{2}$, spring $22\frac{1}{2}$. Through Southern Brazil, Uruguay, and Buenos Aires Province the rainfall is more or less equally distributed throughout the year, with a tendency to a spring maximum, however, in Southern Brazil and spring and autumn maxima on the Pampa.

During the southern winter a broad dry zone extends from the north-eastern angle diagonally, across the continent so as to link up with the Peruvian-Chilean-Patagonian arid region. During the southern summer, on the other hand, a very broad zone of heavy rainfall reaches across the continent from the Upper Amazon to the central part of the Brazilian coast.¹ These two intersecting zones are shown in Fig. 7. When autumn approaches, this zone of heavy rainfall moves along a nearly parallel front towards the north-east and at the same time becomes narrower. By mid-autumn it lies across North-Eastern South America from the mouth of the Amazon to the coast of Bahia. The position and

¹ The zones of seasonal rainfall in South America are remarkable for their diagonal arrangement across the continent : from N.W. to S.E. in the southern summer and from N.E. to S.W. in the southern winter. In the former season there is a succession of seven zones from North-Eastern Brazil to South-Western Chile, in the latter season there is a less marked succession from Colombia to Eastern Argentina.

orientation of these rainy zones at different seasons bear a close resemblance to, and depend largely upon, those of the trade winds. These in their turn are modified by the position and intensity of

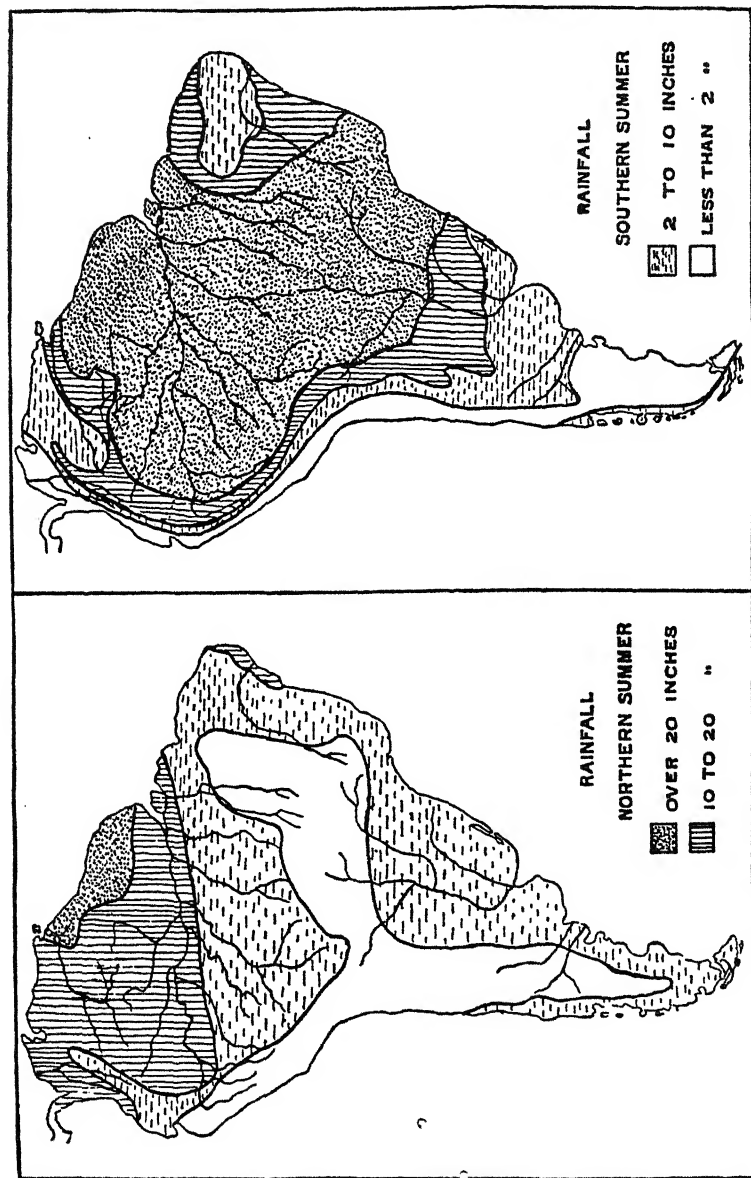


FIG. 7.—Zones of Summer and Winter Rainfall in South America
(The key indicates the rainfall in the summer and the winter months respectively and is to be applied throughout to both maps.)

the interior low-pressure areas consequent upon summer heating, towards the major axes of which elongated areas the winds would

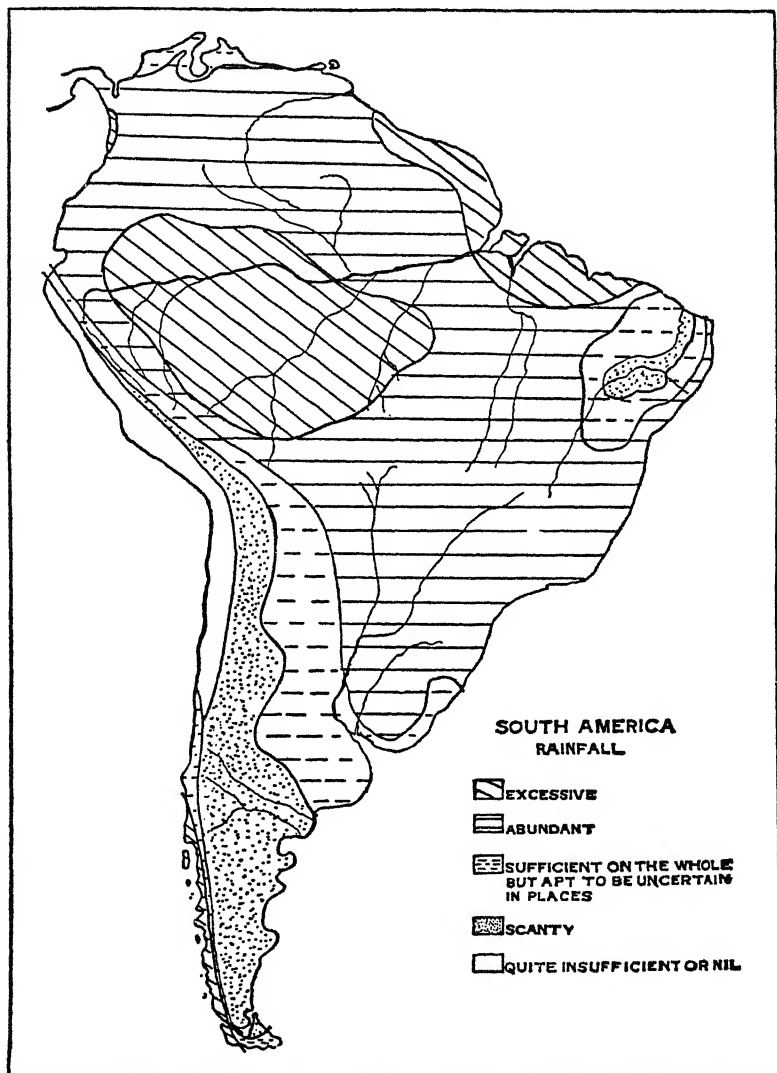


FIG. 8.—Nature of Rainfall in different climatic areas of South America

tend in any case to blow at right angles, following the lines of steepest gradient. The heavy summer rainfall that characterizes South America as a whole must be mainly ascribed to the fact that

the trade winds, after being charged with moisture by the equatorial ocean current, are given added momentum by the arrangement of elliptical summer low-pressure areas across their path in the continental interior.

From Rio de Janeiro to Bahia Blanca the coastal zone is mainly outside the influence of the South-east Trade, and the winds there are accordingly very variable at all seasons except during the summer when the low-pressure system over the Chaco leads to an indraught from the sea. Disturbances in the air are common from September to May, and there is a tendency on the whole towards a cyclonic type of rainfall without marked differentiation according to seasons.

The Peruvian-Chilean-Patagonian arid region (VI) stands in marked contrast with the adjoining regions in rainfall.

The coastal region of Northern Chile and of almost the whole of Peru is practically rainless; its climate approaches more closely to that of the absolute desert than that of any other part of the world. The prevailing winds, though from the sea, scarcely ever bring rain because they are from the south and because the cold Humboldt current that skirts the shore causes them to condense their moisture more effectively than the rising land surface can. Mists resulting from the condensation of moisture at sea are of very common occurrence in the summer months on the coast and at moderate elevations inland, but these are not sufficient of themselves to support any continuous plant life. In the region of Copiapó and thence southwards the temperature of the Pacific waters and of the land surface is considerably lower than in the north and begins to approach that of the Humboldt current. Occasional rains are possible, therefore, at Copiapó, and more on the Andes behind, particularly in the winter season when the land surface is coldest. From Valparaiso southwards the westerly winds become more pronounced and the along-shore current there ceases to be recognizable as an intercepting factor.

The continuation of the North Chilean arid region, on the eastern side of the Andes, in the Argentine provinces of S. Juan and Mendoza, must be ascribed to special rather than to obvious causes. In the first place, the district which includes the provinces mentioned lies in a latitude intermediate between that of the trade winds and the westerlies. The latter would in any case be useless as sources of rain since their moisture would be intercepted by the Andes, but the former, were they strong enough, would naturally tend to bring rains to this region, standing as it does well above the eastern plains; however, in this extreme southern margin of the zone in which the trade winds are felt, they are quite irregular and are incapable of carrying moisture, except

rarely, beyond the eastern coastal districts. The central western part of Argentina lies in fact too far south and too remote from the sea for the continental low-pressure area to be of material assistance to it in causing rainfall.

The Patagonian Territories from Neuquen to Santa Cruz all suffer from a very low average rainfall, generally less than 10 inches annually. In response to the increasing force of the westerlies towards the south, combined with the fall in the height of the Andes in the same direction, the isohyets, running north and south in the main, tend to work away from the line of the Andes and towards the Atlantic as they approach the Straits of Magellan. Western Patagonia thus receives a better rainfall than Eastern Patagonia, and the southern districts fare better on the whole than the central. Over the whole area strong westerly winds are common, while in the southern territories they frequently reach gale force and are apt to be cold.

In the Central Andean sub-arid region (VII) of Cordilleran Peru and Northern Bolivia rain or snow falls occasionally on the plateaus, but not generally in sufficient supply to provide more moisture than is required by grasses and a few very hardy crops. Considerable quantities of snow fall on the high cordilleras on either side of the plateaus and particularly on those to the east, and the streams resulting from the melting of such snow have been for ages used to irrigate crops grown lower down on the floors of the valleys and in terraces on their slopes.

From Central Bolivia southwards into the Puna de Atacama rain falls but rarely and snow by no means frequently. In the former region also the plateau is wider than elsewhere, and both there and farther south is occupied by huge salars or salt-incrusted depressions—a definite indication that evaporation is gaining on precipitation, consisting chiefly of what falls as snow on the high chains and afterwards drains into the plateau basin.

It follows from the position of this central Andean region that the precipitation it receives, whether as rain or snow, must be mainly of Atlantic origin. Pacific air occasionally gets lifted into strata well above the Humboldt current and attracted inland so as to deposit moisture on the Western Cordillera, especially south of the Tropic of Capricorn; but planetary winds throughout the length of this region are mainly from easterly points, and just before reaching it have risen vapour-saturated from the lowlands to the east. Incidentally, it is of interest to note that the irrigated valleys of Western Peru and even those few found in Northern Chile, derive their water in the main ultimately from the Atlantic whose beneficent influence is thus felt from shore to shore almost

everywhere throughout the continent except in the extreme southern peninsula.

In the South Chilean region (IX) the whole zone facing the Pacific from latitude 39° S. has a rainfall of over 80 inches per annum, and a narrow belt extending along the western slope of the Andes receives more than 200 inches a year. Generally speaking, therefore, the rainfall is excessive; and though heaviest during the winter season, it is distributed through all the months in the year.

The climate of the South Chilean region is inhospitable even on the mainland, and becomes still worse in the archipelago section to the south; not only is the rainfall excessive, but the winds are fierce and cold, and the sky almost invariably overcast. In almost every way except as regards the winter type of rainfall does this South Chilean climate stand opposed to that of North-Eastern Brazil. These regions are afflicted by nature with such extremes of drought on the one hand and moisture on the other, of fierce sunlight and gloominess, as to be condemned to develop very slowly compared with the rest of the continent.

The distribution of rainfall throughout the continent during the northern summer season, and again during the southern summer season, is shown in Fig. 7, from which it will be apparent how a maximum north of the Equator in the northern summer corresponds to a minimum south of it during the same season as far south as the latitude of the Rio de la Plata, and *vice versa* in the opposite season. The nature of the rainfall in various parts of South America in relation to the requirements of useful plants including grasses (Fig. 8) is of importance to any consideration of the possibilities for human occupation, present or future, of the several regions.

B. Temperature

Of all the continents South America is the most equable in temperature. Its greatest breadth lies across the tropical zone where the mean annual range is small throughout the world and especially in this continent where in the inner tropical zone between 10° north and south of the Equator the mean range is seldom more than 3° F. (see Fig. 9. A). In the extra-tropical region, on the other hand, South America narrows remarkably, so that the tempering effect of the oceans is felt from shore to shore. The region which shows the relatively moderate annual range of 20° F. (11° C.) and over, is but small (see Fig. 9. B); and were it not for the Andean barrier shutting out Pacific influences to a marked extent from the zone adjacent to it in the east,

this region would be much smaller. The only part of South America that has a really continental climate is a small one in North-western Argentina, in which a maximum annual range

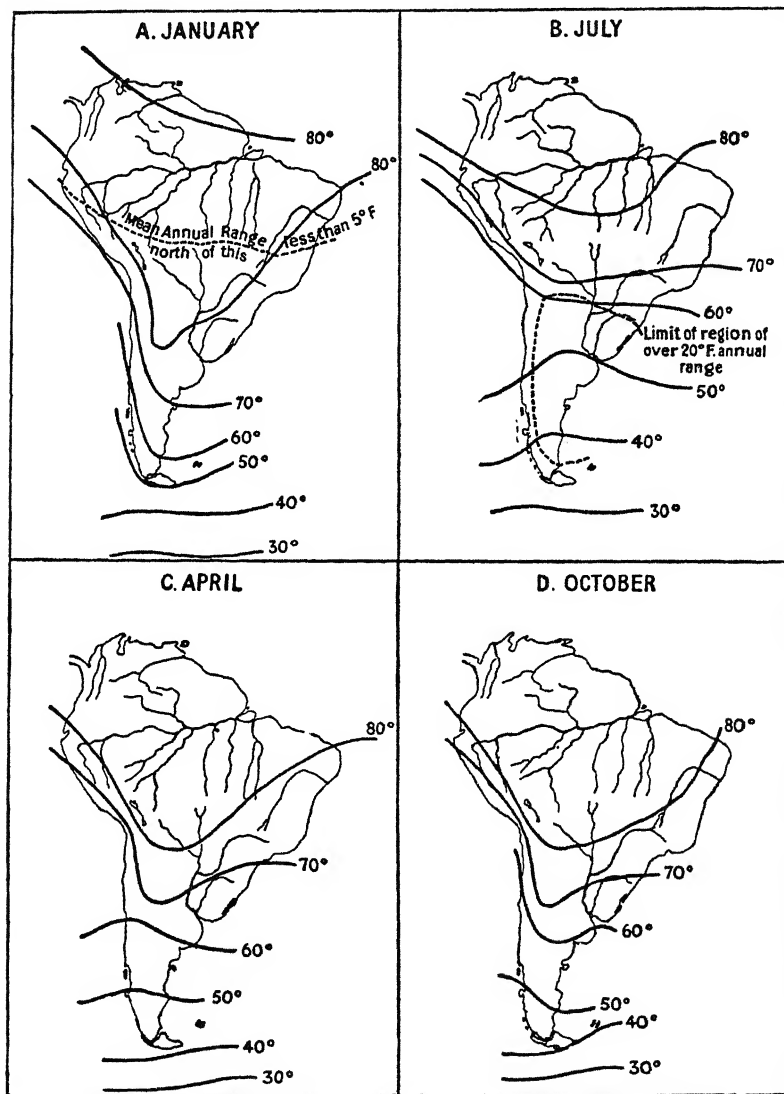


FIG. 9.—Isotherms of mean sea-level temperatures for representative months in South America.

of 30° F. is assigned to Catarmarca. Altogether, the temperature gradients from the coastal districts inland are lower in both summer and winter in South America than in other continents.

A study of the isotherms of mean monthly sea-level temperatures (Fig. 9) reveals a number of special points. Firstly, nearly all the continent north of the Tropic of Capricorn is above 70° F. for every month of the year, owing to the powerful equatorial low-pressure area which rules in the heart of this northern half of the continent, and to the constant inward movement of air from warm seas and over the warm Brazilian current.

Secondly, on the west coast from Valparaiso northwards to the Gulf of Guayaquil, the temperatures are unduly low in relation to latitude throughout the year. The cold Humboldt current does not alone explain this. In addition, there is a welling up of water colder than that of the current, from the oceanic depths immediately off the coasts of Northern Chile and of Peru; further, the winds in this region being associated with the Pacific anticyclone, are cold for the same reason that they are almost rainless, and often envelop the coastal strip in mists which shut out the sun (cf. p. 28). The lowness of the temperatures on the west coast compared with those on the east is shown by the following data: Lima is over 7° F. colder than Bahia in January and over 12° F. in July; Antofagasta is over 7° F. colder than Rio in January and some 10° colder in July; Valparaiso has about the same temperature as Monte Video in July, but is nearly 11° colder in summer.

Thirdly, the west coast from Valparaiso southwards is much cooler than the corresponding east coast in the summer season, but is warmer in the winter half of the year. This is partly to be explained by the great difference in rainfall and therefore in cloudiness. During the summer when the sun is strong, nearly rainless Eastern Patagonia gets the full benefit from his heat, while clouds deprive the Chilean coast of much of this. During the winter, on the other hand, radiation is small from the rain-soaked west coast, but active towards the Atlantic. The higher winter temperatures in Chile are also partly due to the northerly component in the frequent cyclonic storms passing east in the region of Cape Horn, as well as to the southward-moving current off the west coast from about 30° S.

Fourthly, as the result of these special, and other more general, oceanic influences the isotherms for January are all concave towards the north-east, and are accordingly roughly concentric to one another; those for July are still concave towards the north-east as far south as the Tropic of Capricorn, but become

concave towards the Antarctic in temperate latitudes. This convex to convex arrangement of the isotherms in the zone of about 30° S., indicates the much smaller latitudinal spread of temperature in the interior N.-S. corridor of the continent than obtains on either coast. In the continental interior in middle latitudes extremes of temperatures meet in the southern winter, and this explains how the remarkably abrupt changes of temperature may occur at that season in the plains of Mato Grosso (see p. 115).

Fifthly, in the outer tropical zones (10°–20° N. and S.) the coastal regions, even when washed by the relatively warm tropical Atlantic waters, tend to be cooler at all seasons than the interior. This is naturally marked in January when the sun is overhead well south of the Equator and the cooler air from the north invades the coastal parts of Venezuela and the Guianas. It is, however, quite apparent again in April and in October from the mean temperature figures, though not from the widely-spread isotherms. Even in July when the northern coasts of the continent might be expected to be warmer than Amazonia, the latter still has a slightly higher temperature.

Finally, on either side of the whole Andean zone from the Straits of Magellan northwards to the Equator at least, extremes of temperature lie in close proximity at one season of the year or another, and in the Peruvian section throughout the whole year. In contrast with the July distribution in the interior corridor described above, the Cordilleran chains act as an effective barrier to temperature exchange; and where conditions are favourable, great differences in temperature may exist between places not far apart, but on opposite sides of it. Thus in January the sea-level temperature of Salta is 13° F. higher than that of Antofagasta. Similarly also the great annual range on one side, e.g. 30° at Catamarca, is walled off from the very moderate range of about 10° on the Chilean coast on the other side.

C. Elevation

Elevation plays an important part in determining the climates of extensive parts of South America. Although no other continent has so much of its area within the tropics, in no other continent is there so high a proportion of the regions in tropical latitude possessing a temperate or even a polar climate. The Andean zone, broadest and most extensive north of the Tropic Capricorn, furnishes striking illustrations. The highest peaks even under the Equator are above the snow-line, and everywhere there are barren slopes of cold deserts above the highest pastures. Contrary to the usual order, however, the highest habitable parts

are not found close to the Equator, where the clouds and mists accompanying the heavy precipitation reduce the heat received from the sun; but some distance north and especially south, where the climate is drier.¹ The plateau region of Bolivia indeed, not only contains some of the highest permanently populated regions in the world, but also is larger than any other inhabited area of comparable elevation. With increasing distance from the Equator combined with greater dryness, the daily and the annual ranges of temperature, of course, likewise increase, rendering frosts more and more common, and ultimately forcing the cultivation of even the hardiest plants to lower levels than nearer the Equator.

Owing also to the factor of elevation in determining the climate, practically the whole of the Brazilian Plateau north of the Tropic has the warm temperate rather than the tropical type of climate. Thus at Caetité and Formosa, two interior stations near latitude 15° S., mean monthly actual temperatures never exceed 73° F. The southern part of the Plateau tends to have the cool temperate climate, at all events in winter, when frosts occur almost every year.

THE CLIMATIC PROVINCES OF SOUTH AMERICA

When all the climatic data for South America above described are taken into consideration together, it becomes possible to subdivide the continent into the ten following climatic provinces.

I. The northern tropical lowland region with marked seasonal, usually sufficient rainfall, and general high temperatures.

II. The Amazonian equatorial region with heavy rainfall, general high temperatures and high relative humidity. Here there is little distinction between the seasons under any head.

III. The southern tropical region with marked seasonal rainfall on the whole, and wider ranges of temperature than in either of the preceding. This region may be subdivided mainly according to temperature features, into the coastal, the plateau, and the interior lowland zones.

IV. The River Plate region, including the extra-tropical parts of the Brazilian Plateau, with all-season and sufficient rainfall, moderate mean temperatures and moderate seasonal range.

V. The interior sub-arid zone east of the Andes from Northern Argentina into Patagonia with greater extremes of temperature

¹ In illustration of this descent of the habitable zone in the Andes, P. Denis cites three towns of nearly the same elevation—Bogotá (5° N.), Quito (0°) and Cochabamba (17° S.), which have mean annual temperatures of 14.4° C., 12.6° C. and 17.3° C. respectively.

than elsewhere in the continent, the annual range declining from north to south.

VI. The cool temperate region of Southern Chile and Tierra del Fuego, with excessive rainfall, low average temperature and a very moderate range.

VII. The Peruvian-Chilean arid coastal zone having unduly low temperatures both in summer and in winter for tropical latitudes.

VIII. The southern Andean zone receiving an excessive rainfall or snowfall except on the eastern slopes. The heavy precipitation together with the prevailing low temperatures render the region almost entirely uninhabitable.

IX. The central Andean semi-arid zone marked by great daily ranges of temperature. The high eastern valleys are better supplied with moisture and are more equable in temperature.

X. The Equatorial and Northern Andean zone having a heavy precipitation and an equable, if rather low, temperature.

CHAPTER III

THE COURSE OF EUROPEAN SETTLEMENT

AT the close of the fifteenth century and the beginning of the sixteenth, the period that marks the commencement of the modern era in the world's history, the only maritime nations of importance in the world were the Portuguese and the Spanish ; and the fruits of the notable discoveries then made fell in the first instance into their hands. The course of events showed that these two nations were rich in navigators, explorers, and soldiers possessed of extraordinary audacity and energy, such as have never been equalled since the time of the Norsemen. Thus, beginning about the year 1500, they soon established themselves in those parts of the New World that they chose as the main field of their activities. The question of the partition between Spain and Portugal of the newly discovered territories was settled in outline by Alexander VI's famous Bull in 1493 whereby were assigned to Castile and Leon "all islands and lands to be discovered in the seas to the west of a meridian line to be drawn from the Arctic to the Antarctic Pole 100 leagues to the west of the Cape Verde Islands and the Azores." Territories to the east of this line were to go to Portugal. In the following year a treaty was signed at Tordesillas between Spain and Portugal under which the line was moved 370 leagues farther west, or some $23\frac{1}{2}$ degrees in all, beyond the Azores. This revised line corresponded roughly with the 48th meridian which traverses South America from the mouth of the Amazon in the north to a point on the Atlantic in the south on the coast of what is now the Brazilian state of Paraná. (See Fig. 10.)

The two interested nations, having thus delimited their spheres, proceeded to found settlements and to conquer almost simultaneously the territories assigned to them in the New World. The Spanish first established themselves in the West Indies and then used these as a base from which they sent out two streams of conquest, one westwards and north-westwards into Central America and Mexico, the other Southwards down the Central Andean Plateau and thence on to Chile. The Portuguese from the first, owing to the relative proximity of Eastern South America

to Portugal, were able to rely directly upon the sea-link, and eventually occupied a territory very large indeed having regard to the physical difficulties encountered on the one hand and the population and resources of the home country on the other.

In one direction the Spaniards had an easier task in laying the foundations of a vast colonial empire in the New World than had the Portuguese. For they found more or less highly organized systems of government in three separate territories, Mexico, New Granada and Peru. Once the central power in each of these was overthrown, a task of no supreme difficulty owing to the superior weapons in the hands of the invaders—the population, accustomed to submit without question to authority, came almost automatically under the complete control of the conquerors. Thus within a space of about thirty years from the time that the Spaniards first obtained a footing on the mainland, their dominion extended, with certain breaks, along the western shores and over the plateaus for a distance of more than 3,000 miles from the Northern to the Southern Tropic. Before the close of the sixteenth century the Spanish colonial empire had practically attained its maximum extension.

The Portuguese proceeded at a slower pace in Eastern South America. Not only had they to contend in the main with scattered and unsubmissive tribes on the plateaus, but were compelled in the first instance to settle at various strategic and easily defended points along the hot and unhealthy coastal plain, covered for the most part with tropical jungle, in order to secure themselves from the assaults of European rivals. Rio Bay, for example, after its discovery in 1531, was first settled by the French in 1558, and not till 1567 did it fall into Portuguese hands. The long coasts of Brazil were, in fact, peculiarly open to attacks, not so much on the part of the native tribes from the land, as on the part of other maritime nations in Europe from the sea. Had the English, French and Dutch been less occupied with quarrels among themselves, it is extremely unlikely that the Portuguese would have been able to retain so much territory in the eastern part of South America. As it turned out, however, the three nations above mentioned carved for themselves not even the smallest slices out of the vast domains east of the boundary agreed upon between Spain and Portugal in 1494.

The Spaniards, not content with obtaining possession of the West Indies and the western regions of the two new continents, turned their attention also to that eastern part of South America situated within their sphere to the south of the Portuguese territory. The Rio de la Plata was discovered by a Spanish explorer in 1515 and Sebastian Cabot sailed up both the Uruguay and the

Paraná Rivers some twelve years later. The early attempts at settlement, particularly that at Buenos Aires in 1554, proved more or less failures owing to the hostility of the nomadic Indian tribes. Eventually, however, Spanish authority was established at the Rio de la Plata and along a line that extended north-west across the Pampa and the dry country beyond, linking up the Atlantic with the settlements on the Andean Plateaus. North-Western Argentina was in fact settled from Peru, Tucumán being founded thence in 1565 and Córdoba in 1573, while the permanent occupation of Buenos Aires dates only from 1580 and was effected not from the Atlantic, but from Asunción where a Spanish fort had been established in 1537 shortly after the first and disastrous landing at Buenos Aires. During the two succeeding centuries there were constant rivalries in the border country along the Paraná and Uruguay between the Spanish and Portuguese colonial settlements, which gave birth to feuds which lasted many years after the people in this part of the New World had ceased to owe allegiance to Spain and Portugal.

In the northern part of South America any serious clash between the two powers that divided the continent between them was rendered exceedingly unlikely by physical conditions. The huge forested area of Amazonia lay as a barrier between the Spanish possessions in the north and the west and the Portuguese in the east. Throughout the colonial period, and even to the present day, this region has had a marked centrifugal force in its effect upon settlement and the distribution of population; and since the Amazonian forests throw a long tongue southwards between the Brazilian Highlands and the Andean Plateaus which remains even now more or less impassable, the north and south frontier between the Spanish and Portuguese territories of colonization was sufficiently well defined by nature.

It is indeed remarkable that the line adopted in 1494 before there was any notion in Europe as to the disposition of physical features in South America, should prove to correspond so closely with a line of well-defined natural barriers from north to south in the southern continent. There were first the Guiana Highlands, densely forested on their northern slopes, then the great equatorial forests of the Amazon Basin extending outwards via the Madeira Valley till they joined with the marshes and forests of the Paraguay-Paraná line, which continued in their turn practically uninterrupted to the South Atlantic at the Rio de la Plata. This coincidence must be regarded as one of those accidents that make history. For it is hard to believe that, if these two European powers had not been effectively separated in their activities in the New World, they would have been able to devote

their energies so whole-heartedly to establishing themselves in their respective spheres. The favourable feature of strong natural defensive barriers in the conditions under which each of these powers pursued their colonial expansion in America finds its counterpart in the conditions under which the civilizations of Egypt, Mesopotamia and Northern India arose at an earlier time, in the Old World. It is not without significance in this connection that the coastal plain of the Guianas, widely separated by the barrier of the Lower Amazon forests from the main mass of Portuguese settlement in what is now Brazil, should have fallen to the European rivals of the Portuguese.

The startling rapidity with which the Spaniards effected their main conquests in the New World is striking enough, and the leading cause has already been noted. From the standpoint of historical geography certain peculiar features in this march of conquest have now to be observed.

On the Caribbean shores and also along the Gulf of Mexico and for about 10° south of Panama along the western coast of South America, the lowlands are hot, unhealthy and largely covered with jungle. They are thus usually quite unsuited to European settlement. From the Equator southwards along the west coast of South America all the way to Central Chile the coastal region is equally unsuited, except where irrigable, to settlement of any kind. Once they reached the mainland, therefore, the Spaniards made as quickly as possible for the plateaus beyond the coastal belts, as much because these belts were untempting, as because the already more or less civilized regions of the plateaus offered chances of easily won wealth. Spanish power in the New World outside the West Indies thus became distinctly concentrated in the inland districts and its hold on the coastal regions correspondingly weak. Such centres as Cartagena, Lima and Copiapó served merely as links in the chain of authority extending from Spain to the districts beyond. They were artificially created in that they derived their importance almost entirely from the peculiarly centralized form of government established by the Spaniards in the New World.

Though Spanish authority eventually extended from the northern plateaus into the Pampa surrounding the River Plate and into Central and Southern Chile, its progress from the central plateaus into these regions was relatively slow, for between lies a broad belt of deserts extending from the west coast across the Andes and into the plain beyond. Immediately after the fall of the Inca Empire, it is true, both Almagro and Valdivia penetrated by hazardous routes into Chile, but it was not till some years later that a permanent foothold was established by the latter, Santiago

and other centres being founded between 1540 and 1550. It is interesting to note that the line of communication that eventually linked the Pampa with Spanish power in the north lay along a strip between the western desert and the eastern forests and marshes on the border of the former, and was marked by a string of oasis-like combined forts and revictualling settlements such as Tupiza, Jujuy, Salta, and Santiago del Estero. The link with Southern Chile, on the other hand, once it was established, was maintained as much by the sea route along the coast as by land over the deserts of Northern Chile where oases were few and far between.

Compared with the Spanish conquest of the western regions, that of the eastern by the Portuguese, as already observed, was considerably slower. Several outstanding causes contributed to this difference. In the first place, the population and the resources of Portugal were naturally much smaller than those of Spain, which had the added advantage at the time that the New World was made known to Europe, of having achieved complete unity under a vigorous, if absolutist, form of government. Secondly, the Portuguese were attempting at that time to establish and to maintain an East Indian Empire, so that their efforts were scattered, while the Spanish were able to devote undivided attention to their colonial ventures in America. Thirdly, such political and social organization as existed among the native peoples was favourable to the invading European power in Mexico and Western South America, but the eastern districts from the mouth of the Amazon to the Rio de la Plata were occupied by the war-like Tupi-Guaraniés, who rendered the early stages of settlement by the Portuguese dangerous on the coast and necessarily slow inland.

Geographical features in Eastern South America, at all events in Brazil, bear this much resemblance to those in the former Spanish colonial domains, that beyond the forested coastal lowlands from the eastern edge of the plateau there are large areas of more or less open country which in the early days facilitated movement and conquest. Thus, when the Portuguese, having established themselves at three or four main centres along the coast, gained the uplands beyond, their progress was relatively rapid. Before the interior fell permanently into European hands, however, sufficient time had elapsed for a population of mixed Portuguese and Indian descent to arise and to form an important part of the fighting forces on the side of the Europeans. Among these mixed elements those of São Paulo, known as Paulistas, were the most prominent in carrying European arms into the far interior. In the development of Brazil during this stage, river valleys played a much more important part as lines of penetration than ever they

did in Spanish America. The Paraíba Valley afforded then a route for bands of adventurers, as it does now for the railway, from the neighbourhood of Rio to the plateau lands of São Paulo, from which the Paulistas pushed westwards by way of the Tieté Valley to the longitudinal line of the Paraná and beyond into the savannahs of Mato Grosso. A similar story was repeated with the expansion from Salvador (Bahia) which reached the valley of the São Francisco and then utilized that long corridor as a route by which to penetrate to the heart of the plateau in Minas Gerais. In Northern Brazil the Paraíba Valley led the invaders far south towards the São Francisco, while the Amazon provided a navigable highway into the interior lowlands, Manaus having been founded from Maranhão in 1660, forty-four years after the foundation of the parent town.

The geographer is not concerned with political institutions and systems of government except as far as they become factors in racial or economic development, or are themselves the outcome mainly of physical causes. As regards the course of European settlement in South America, however, something more than a passing reference requires to be given to the general systems of political and social organization carried by the Spaniards and the Portuguese into the New World. For these systems, different in some respects, but alike in others, had grown immediately out of the conditions in the home countries in the pre-discovery period, and had widespread effects upon the life and development of the Spanish and the Portuguese territories in America.

The long struggle with the Moors had rendered the Spanish a martial nation, and indirectly, since the conquered Moors supplied a labour force for manual and menial tasks, led to a contempt for active work, to the traditional *deshonor del trabajo*, among all classes above the lowest. The power of the monarchy had increased enormously with the union of the crowns of Castile and Leon, and an elaborate system of autocratic rule had been devised whereby the sovereign exercised a minute control over the political and religious life of the nation. Transplanted to the New World these peculiarities of the Spanish outlook and political organization bore distinct fruits. The Conquistadores were brave, but brutal and inhuman; they were excellent soldiers of fortune, but, knowing little of the arts of peace, were inefficient administrators. The Spaniards who went to America, whether as soldiers or as treasure hunters, were all of the same mind in regarding productive work as an indignity.¹ From the beginning to the end,

¹ "En la madre patria arar la tierra es tarea de villanos y siervos: en America de tontos. . . . Sobre todo quieren vivir como grandes señores, mandar a los indios, negros y criollos."—"In the mother country

the Spanish colonial empire on the mainland of America was regarded as an affair in which the Crown in Spain had a leading interest as the chief partner. The whole enterprise was managed from Spain by the government there which, though not devoid of humane ideas, regarded it primarily as a means of bringing treasure to the exchequer. In almost every one of these features the Spanish Empire in America contained the seeds of its own destruction. There was no possibility of, as there was no place for, a body of peasantry migrating thither to form the nucleus of a vigorous Spanish agricultural population. The premium put upon greed and corruption among the limited official class led to the wholesale destruction of the Indian population in the mines and elsewhere ; and in the circumstances this population was the only source of labour for effective development in the long run. Further, the close regulation of the trade of the whole American territory by the Spanish Government in the supposed interests of Spain led to evasions, excited the envy and the attacks of other nations, and finally produced the keenest resentment from Mexico to Buenos Aires. This resentment was one of the prime causes of the successful move for independence early in the nineteenth century. One distinguished writer has stigmatized Spanish rule in America as " the most ill-conceived and ill-administered scheme of government that selfishness and stupidity ever combined to devise." ¹

The immediate antecedents of the colonial era in Portugal, though roughly parallel with those in Spain, differed in some important particulars from them. Like the Spanish, the Portuguese at this time were vigorous and hardy and were filled with martial ardour. They had suddenly risen to a prominent place among European nations owing to their position at the south-west corner of Europe and to their good fortune in having had a line of able rulers. Under the leadership of Prince Henry the Navigator they had taken the foremost place among maritime and exploring peoples, and in spite of a small population, numbering in all about a million, were keen to expand whither new discoveries should point the way. The Portuguese system of government, though efficient, does not appear to have been so highly centralized as that of Spain, considerable initiative being allowed to the great nobles, at all events in the matter of colonial ventures.

the cultivation of the soil is an occupation for serfs and slaves : in America for fools. . . . Above all, they (the Spaniards in the New World) wish to live like great lords, exercising authority over the Indians, the negroes and the native-born."—"Congreso de Historia y Geographia Hispano-americano: Actas y Memorias," Seville, 1921.

¹ Viscount Bryce: "Impressions of South America," 1912.

Thus when the Portuguese reached the New World, their mode of settlement differed from that of the Spanish. Spacious territories in the form of captaincies were allotted to military leaders, without the same close supervision from the home government to which the Spanish viceroys were subjected. In fact, Portugal being a small country, was unable to push a rigid centralized authority overseas, even if she had wished to, or later on to establish a thoroughgoing commercial monopoly in the colonies in spite of attempts to do so. It is noteworthy that the Inquisition was never introduced into Brazil. The bond between Portugal and her colonial possessions in America was, in short, much more flexible, in virtue not only of the above-mentioned facts and of the link by sea, but perhaps more especially, because owing to the relative scarcity of precious metals and the lateness of their discovery in Brazil, the Portuguese colonists there were much more of the settled agricultural type than elsewhere in Latin America.

The Portuguese system in America had inherent defects. Under the captaincies particularism was very marked, and this proved a serious weakness in the struggle against internal and external foes. After the establishment of a Governor-Generalship, first at Bahia and later at Rio, the feudal system of captaincies continued to operate in thin disguise with the result that Brazil has moved very slowly indeed towards national integration; and throughout almost the whole of the northern part of the country the system has left an evil heritage of large estates and obsolete laws relating to the ownership of land. In spite of its defects and of the inefficiency and corruption of the administrators, the Portuguese system achieved wonders in America in acquiring a territory there eighty times as large as the mother country, nor did it contain such economically disastrous features as the Spanish system. The break with Portugal when it came in the nineteenth century was a gradual one, and was achieved without serious bloodshed.

Both the Spaniards and the Portuguese undertook tasks of colonization and settlement wholly disproportionate to the home populations they had at their disposal, but the Portuguese rooted themselves much more firmly in the New World by taking to agriculture, whether in the form of stock-rearing in the north or of plantation agriculture along the coast and in the south. The large estate-owners, living with numerous dependents in a semi-patriarchal way, formed a bulwark against frontier attacks and against disruption. To this day the Brazilian is primarily a man of the country, not of the towns. The Spaniards in America, on the other hand, relied more on force imposed from above and

less upon permanent settlement as a means of retaining their hold. The result was that the handful of Spanish in the colonies (estimated at 160,000 at the close of the sixteenth century) was quite unequal to keeping vast territories permanently in tutelage as conquered provinces, held to be of value only because of the tribute that could be extracted from them.

Throughout the three hundred years of the colonial period the settlement and development of South America was distinctly peripheral in the main, and this characteristic has lasted right down to the present century. With the exception of small scattered centres along a few well-marked routes penetrating by river valleys or across the continent in the narrower southern section, almost the whole of the effective population lived till recently within about 300 miles of the coasts. In Spanish America the population of the plateaus never lost touch with the Pacific ports, and though the Portuguese in Central Brazil spread tentacles far inland, settlement in that country has been as closely linked with the Atlantic as was the Spanish with the Pacific.

The lowlands east of the Andes from the Colombian tributaries of the Orinoco to Southern Bolivia are effectively cut off from the plateaus, even till the present time, by the wild and densely forested Montaña region. Farther south the forest barrier first weakens and then disappears, but between the western coastal strip in Chile and the valleys of North-Western Argentina lies one of the most inhospitable deserts in the world, that of the high Punas, over 200 miles in width in Bolivia, but gradually narrowing towards latitude 28° S. into the single massive chain of the Andes (Fig. 32). Thus the connecting links between the Pacific and the Atlantic Spanish settlements lay either along the line already described from the Bolivian Plateau to the Pampa or crossed the Andes below the Puna region, as for example, via Mendoza and S. Luis. The difficult routes over that region were avoided until the opening of the nitrate fields in Northern Chile gave rise to heavy demands for cattle from the eastern plains and valleys directly across the mountain system.

It is not surprising that Spain and Portugal, which never had any great surplus population, should have been unable to occupy any but selected portions of the continent otherwise than nominally. Even if their resources for colonization had been immensely greater, large areas must have remained unoccupied by them, at all events till the mechanical age began to make itself felt in remote continents well on in the nineteenth century. It has been said that man is overburdened by

nature in South America as in no other continent ; the tropical forests are too vast, the plateaus too high and the deserts too arid for successful conquest. During the three centuries that followed the conquest, all of the continent that was effectively

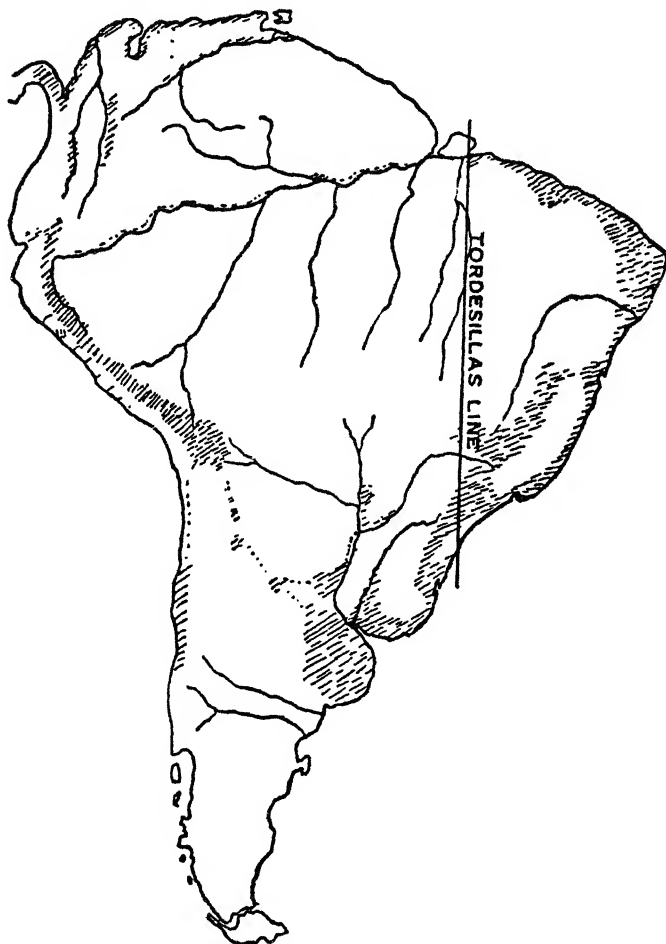


FIG. 10.—Areas of European Settlement about the year 1825

occupied by Europeans consisted of a series of strips and lines of penetration as shown in the map, Fig. 10. Till late in the nineteenth century vast areas remained more or less in their original state, the home of scattered Indian tribes. Such were the Orinoco plains except here and there along the lower course

of the river, the Guiana Highlands but for an attenuated strip along the coast, almost the whole of the great basin of the Amazon and the interior of the Brazilian Plateau, another great area in the Chaco lowlands, and practically all the southern peninsula from 40° S. Altogether quite three-quarters of the continent. Of these areas fully half has remained unoccupied and in many places even unexplored till the present time. The Spanish and Portuguese peripheral occupation of South America and the Monroe doctrine have acted together to withhold a large part of the interior from the civilized world and to delay its development for upwards of a century. It may not be altogether a bad thing for the world at large that vast productive areas have thus been reserved for the future by the events and accidents of history, but the above-mentioned circumstances go far towards explaining the relative economic backwardness of South America.

The scattered nature of the settlements under European control in South America during the long colonial period gave rise to routes overland connecting them with one another or with their sources of supplies. From pre-Columbian times there has always been an active exchange of products between the plateau and the adjoining plains. The most striking of these routes was that over 2,000 miles in length from Lima via Abancay, Cuzco, La Paz, the Humahuaca quebrada and thence to Buenos Aires. There were many others, however, shorter in length, but widely used at one time or another during the three and a half centuries between the conquest and the coming of railways. One proceeded from the mining centre of Potosí south-westwards towards Chile via Calama and thence to Antofagasta, others crossed the Andean system between Chile and the Pampa, either by way of San Pedro de Atacama in the north, or via the Copiapó River, the Chascuil Valley, Fiambalá and Tinogasta, or by various passes in the Andes farther south, of which the Cumbre or Uspallata is the best known.

In the eastern part of the continent, there was an important route known as the salt trail from Buenos Aires to Salinas Grandes in the south-western section of Buenos Aires Province, and a continuation of this route from the Pampa led to the cattle-trading centre at Choel Choel island on the Río Negro, whence cattle were dispatched by way of Lake Nahuel Huapi and other routes to Chile. In Brazil there was an important route in the pre-railway era from Rio de Janeiro to Ouro Preto and another running north from São Paulo to the same district. Of all the old overland routes in Eastern South America the only ones that now preserve their former importance are those to the coast from the stock-rearing districts in the sertão country of

Ceará and Rio Grande del Norte; and even there railways are beginning to absorb the traffic.

A striking feature of these South American land routes was that the most important traffic that passed over them consisted of cattle and mules; both classes of animals towards the mining centres in the Andes, and cattle from the interior to Eastern Brazil. Goods were also transported along them, but in very limited quantities owing to high charges—tobacco, coffee, mate and sugar towards the inland centres, and in the reverse direction mainly minerals. With the fall in the output of silver in the Viceroyalty of Peru towards 1780, the supplies of cattle and mules sent thither by the route from the Pampa declined, and the same fate overtook the trade in cattle from the inland districts in Brazil to the plantations on the coastal belt when about a century later the latter began to stagnate with the abolition of slavery. From the inland regions in Brazil, however, and from the interior of the Pampa, there was and still is one product of the pastoral industry that can bear transportation by long trails to the coastal towns, namely dried hides.

The wars of independence in South America, fought out from Venezuela to Central Chile, emphasized the inherent weakness of the Spanish system of government and the peculiar difficulties in the geographical conditions that the royalist forces had to contend with. It was wellnigh impossible for the Spanish governors in the various centres to move troops rapidly from one point to another over wild mountains, across deserts, or through dense forests; thus the dispatch of relief forces to a hard-pressed centre was out of the question. The insurgents, however, had command of the Pacific, and the leaders with picked forces were able to storm one stronghold after another and force it to surrender. The obstacles to movement by land, and the advantages of that by sea were again emphasized in the Pacific War of 1879–1882. Spain's hold upon the New World was doomed, in short, as soon as she ceased to be a naval power.

The new states that emerged after the Spanish rule was thrown off assumed the boundaries of the old Viceroyalties and Governor-Generalships. The frontiers between these administrative provinces and between them and the Portuguese territory had never been accurately defined, especially in the parts immediately east of the Andes. As a result disputes have arisen from time to time, particularly with the discovery or development of formerly unsuspected resources in the interior or near the lines of the roughly drawn frontiers. There have been wars and threats of wars, and certain areas, notably in Upper Amazonia and the Chaco, were till recently in dispute.

During the colonial period there would have been great difficulties in making detailed surveys, and the idea probably never occurred to the Spanish authorities at home who had little interest in such methods of accuracy. If they used maps at all for the purpose of delimiting colonial provinces, they had only the roughest at their command. They gave rather scant attention to topographical features, with the result that natural boundaries are uncommon between the Spanish-speaking republics of South America north of the Tropic of Capricorn. Somewhat arbitrary lines separated the provinces which are now represented by the republics of Colombia, Ecuador, Peru, Bolivia, from one another and from the provinces to the south. Only between Chile and Argentina is there a natural boundary in the form of the Andes, but till late in the colonial period the area that now forms the Argentine provinces of Mendoza and San Juan was known as Cuyo and was attached to the Viceroyalty of Chile. In the interior of the continent, however, where rivers are numerous, international boundaries sometimes, but by no means always, follow lines marked out by water-partings and to the extent that they do so, they are soundly based on natural features.

The superior habitability of the Andean Plateau zone compared with the adjoining zones, its political importance in pre-Hispanic times under the Incas and the people to the north, and the centralization of Spanish settlement there owing to the mineral wealth, have combined to make it a heart-region of actual states, not a frontier zone. It has succeeded in attracting to itself not only the coastal belt to the west, but also a wide tract of territory in the lowlands to the east extending to the borders of the Portuguese and Brazilian domains. Throughout the world, generally speaking, the plains attract the mountains, but in this part of South America the reverse has taken place. Thus Colombia, Ecuador and Peru all include three climatically quite distinct regions, so also did Bolivia until the Pacific War resulted in the loss to her of the western coastal strip. Communication between one and another of these regions in the above-mentioned countries is very difficult, and that east of the Andes tends to remain isolated and very sparsely populated. The western republics in South America lying north of Chile are faced therefore with peculiar difficulties in their attempts to create homogeneous states; the political fabric tends to break up into various parts according to geographical divisions.

Other republics in South America share this disadvantage. Venezuela has two, perhaps three, geographically distinct regions within her boundaries, and Brazil, though topographically somewhat more uniform in its most important subdivision, namely

the plateau, contains within its vast territory marked differences in relief and climate. In the latter country, even in the more or less settled plateau, three economic groups, the pastoralists of the north, the cultivators of the centre, and those following mixed farming in the south, tend to drift apart owing to divergent interests and remoteness from one another.

The caprice of historical events and the dispositions made by rulers in Europe who had no knowledge of local features, have been mainly responsible for bringing diverse geographical regions together under single government in a number of South American republics. The results have been unfortunate because the lack of geographical homogeneity has been one of the prime causes of the only too frequent revolutions that have occurred since independence was gained a century ago. The unscientific drawing of frontiers has been a serious obstacle to the progress of the continent as a whole. Destructive weapons of offence have been introduced into the countries of South America much more quickly and readily than efficient systems of central government. In other words, statesmanship and railways are products of slow growth, at all events among the Latin peoples and mestizos of South America, and the old fighting spirit inherited from the conquistadores and from the long period of frontier warfare in the earlier days dies hard. Slowly but surely, however, interest in economic pursuits is gaining the field even in these physically heterogeneous states, as it has done for some time past already in the three consolidated and geographically more or less simple republics of the South.

The economic development of South America has been slow in proportion to the resources, even when allowance is made for the great physical obstacles man has encountered there. The concentration of attention on the search for precious minerals on the part of the Spanish proved unfortunate. It resulted in a wholesale destruction of life among the Indians and it absorbed an incredible amount of labour for the mere services of transportation. When the richer deposits became exhausted towards the end of the eighteenth century, and still more, when in the nineteenth century with the discovery of valuable mineral deposits in North America, Australia and Africa great advances were made in the technique of mining in other parts of the world, Spanish South America found itself left in a backwater. Brazil suffered in a similar way but not nearly to the same extent, owing to its much smaller dependence for wealth upon minerals.

The limited number of Europeans that crossed to South America during the colonial period, together with the existence of a submissive native population, led to the creation of large

estates in most of the more desirable parts of the continent, and these estates have persisted till the present time, setting a premium upon extensive and wasteful methods of exploitation, and giving rise to serious social and economic problems. Even in Argentina, Uruguay and Chile, where Indians were few and unsubmitive, much of the land is held in large estates, constituting an obstacle to internal colonization. On the Pampa and in Southern Brazil indeed, the simplest form of the pastoral industry, very much akin to hunting, lasted throughout the colonial period and even later, owing to the fact that the products resembled those of Spain and Portugal too closely for any marked agricultural development to take place. The existing subdivision of the land in large holdings is a direct heritage of this long period of "squatter" occupation.

In this survey we are more especially concerned with economic developments, and these, moreover, have come to occupy a place of increasing importance in the history of South America since 1825. Throughout the period of European occupation there have been three main sources of wealth, namely mining, stock-rearing and tropical agriculture, to which temperate agriculture must be added as starting towards the close of the nineteenth century. The three main industries have undergone various fortunes during the last hundred years.

When independence was achieved by the former Spanish and Portuguese colonies, the mining industry had passed its zenith, and stock-rearing was in a corresponding state of decline. Towards the middle of the nineteenth century, mining declined still further owing to competition from more easily-worked and accessible deposits and better organization in other parts of the world, but products of the pastoral industry such as wool and hides began to find their way to Europe. During the first fifty years after independence, tropical agriculture, with which may be included the extraction of certain peculiar indigenous products from the tropical forests, was in a fairly flourishing condition owing to the heavy European demand for sugar, cacao and similar articles.

The fifty years from 1875, and especially those from 1900 to 1925, witnessed sweeping changes in the whole economic life of South American countries, in which each of the major industries shared. The introduction of foreign capital and the construction of railways contributed much to these changes, which, however, were produced primarily by developments in the world's demand for various products, in conjunction with the relationship of that demand to supplies from competing sources.

The mining industry in South America has become less

specialized as to the minerals exploited. Nitrates, petroleum, tin, copper, manganese and a number of other minerals were added to gold and silver in the list of exports. Improvements in communications and modern metallurgical processes rendered possible the working of vast deposits of low-grade ores that formerly could not be touched. Powerful foreign and even South American syndicates have obtained concessions in many mineralized areas, with the result that the continent has risen once more to the forefront as a source of minerals other than coal.

The pastoral industry has developed extraordinarily, especially on the Pampa and in the surrounding regions, since the introduction of refrigeration. The European demand for meat has been paralleled by that for wool, hides and skins, and stock-rearing for the export trade has made strides in other parts of the continent besides those mentioned. The stock-rearing industry as it existed eighty years ago, producing dried and salted beef for the Latin American market and only hides and wool for export to Europe, was in a more or less stagnant condition. Thanks to the changes that have taken place since then, it has become a flourishing one.

Tropical agriculture went through a period of depression in the last quarter of the nineteenth century, owing to a variety of causes, some world-wide, others local. The rapid increase in beet sugar production in Europe and the opening up of vast new temperate lands reduced the dependence of the world at large upon the tropics as sources of food; the growth of plantations of sugar, cacao and other tropical crops in other parts of the world where labour was cheaper and more plentiful, hit South American producers severely; the abolition of slavery in Brazil, the chief producer of tropical crops in the continent, made competition with other sources more difficult for that country. Side by side with this stagnation, however, developments were in progress. Coffee-planting on a large scale was established in Brazil during the last quarter of the nineteenth century, and by 1900 that country was the world's leading source of supply.

The vicissitudes of the extractive forest industries, such as those devoted to rubber and cinchona, will be described later. Suffice here to say that they developed, reached their zenith and then rapidly declined, all within the last sixty years.

After periods of abundance of food supplies late in the nineteenth century and in the 1930's, the world at large seems likely for some time to come to experience shortages, causing it to turn to tropical sources for supplementary supplies (see p. 295 below).

In this revived interest in tropical agriculture the South American continent has already had some share, and with its enormous productive resources, is bound to have a greater one in the near future.

The rapid increase in the production of cereals on the Pampa is one of the striking features of later developments in South America. Agricultural products raised there surpassed in value by 1904 those of the earlier-established pastoral industry and are yearly leaving them further and further behind. Together with this and the other developments above described there has been a steady stream of migration to South America from Europe, mainly from the Mediterranean countries, and this influx of immigrants has contributed an appreciable factor to the notable increase in the population of the southern continent in the period 1910-55.¹

The collapse in the prices of primary products in the world depression period 1929-33 caused the leading South American countries to turn away from specialization in primary industries for export trade towards a self-contained policy in which industrialization has played an increasing part. The economic revolution initiated about 1930 was furthered by the curtailment of import and export trade during the second Great War, notably in Brazil and Argentina, in each of which upwards of a million workers are classified as industrial, and in a smaller but growing measure in Chile, Uruguay and Peru. The national governments have fostered these developments, not only by high protective tariffs, but also by subsidies, exchange control, direct financial aid, control of internal and coastwise transport and the establishment of special assistance commissions. The artificial stimulation of processing and manufacturing industries has been pursued in the search for adjustment to disturbed conditions of international trade and to adverse terms of trade for primary products against manufactures. It seems doubtful, however, whether even the most progressive South American countries, with their limited technical experience, will find it worth while to push industrialization further, in view of rising relative prices for primary products.

¹ Estimated population 1910, 50 millions; 1931, 84 millions; 1940, 90 millions; 1950, 111 millions; 1955, 124 millions.

CHAPTER IV

COMMUNICATIONS

WITH regard to communications South America is a continent of contrasts ; places that few people want to get to and that have little intercourse as yet with the world at large are easy to reach from the ocean, while extensive areas that have attracted European adventurers and colonists for four hundred years still remain comparatively inaccessible and isolated. Only one important productive part of the continent, namely the delta region at the head of the Rio de la Plata Estuary, is readily accessible by water highways. Elsewhere movement into the interior presents difficulties not unlike those encountered in Africa. It is true that four great navigable rivers in South America, each having one or more great tributaries, make it possible to sail far inland, but development has proceeded slowly in the upper basins of the Amazon, the Paraguay-Paraná, and the Orinoco, owing to the existence of extensive tropical forests in each ; and the Magdalena, though it serves as a highway between the populous Bogotá Plateau and the coast, does so only by means of two stretches of railway. The remaining rivers of the continent are of little use for navigation, since either they are mere mountain torrents, or they more or less dry up during part of the year, or they have their lower courses broken by rapids.

The mountain walls that lie close to the west coast throughout, and also border the east coast for a considerable distance, are great drawbacks to the development of the continental interior. The Andes constitute a formidable obstacle all the way from Central Colombia to Southern Chile, not only on account of their great height—the lowest passes being generally at an elevation of 14,000 to 15,000 feet—but also because the ascent is correspondingly steep, and the climate for the most part extremely arid. The eastern face of the Brazilian Plateau, though not nearly so high as the Andes, is equally steep, is clothed for the most part with dense tropical vegetation, and in the central region is subject to a heavy rainfall which is apt to play havoc with roads and railways and to give rise to slip-

ping rock surfaces which enormously increase the charges for construction and maintenance.

Throughout the colonial period the chief means of transportation were mules and horses, the latter only on the southern plains. Both Spaniards and Portuguese in the course of their penetration and settlement, sought out routes that avoided the forest, that traversed the open, even if partially arid, country on its margins. Between the coast and the plateaus, which were sought because there life is more amenable for Europeans, communication was maintained by means of mules. These animals, however, are sure-footed, and the need for constructing permanent roadways did not become urgent. Till recently there was a marked deficiency of good roads in South America; and even now much of the road mileage given for the various countries consists of unsurfaced and generally ungraded tracks serviceable only in the dry season. The difficulties of construction and maintenance have been as great as varied: steep mountain slopes in the Andes and in Eastern Brazil, heavy seasonal rainfall over much of the tropical zone, sandy deserts on the west coast, absence of stone on the Pampa. With the advent of motor transport, however, not only has increased interest been taken in road construction, but it is realized that the further development of land transport lies more in building roads than in extending railways. The national highways of Venezuela (see p. 98), and the largely completed Pan-American highway from Venezuela to Central Chile are the most notable achievements, but in almost every country the construction of surfaced all-weather highways is being seriously undertaken.

Owing to the scarcity of practicable routes up the steep mountains on the eastern and western sides of the continent and the great difficulties of railway construction along those available, the number of lines in operation in these parts is very small in proportion to the areas to be served. Lateral branches are constructed only when the interior uplands are reached, and the systems assume the same bottle-neck outlines as those of the great rivers. Even when the crests of the plateaus have been gained, progress in the original direction into the interior is by no means easy. Beyond, there are often deep valleys followed by other steep ranges or scarps. In Brazil the valleys are occupied by rivers, many of which are so large and liable to floods as to give rise to serious bridging problems. In the Andes the plateau region north of Bolivia is very much cut up by longitudinal valleys, often resembling great ravines, which make it prohibitive to carry railways farther across the mountain system. The Paita gap, for example, in the Western Cor-

dillera of Peru, though less than 9,000 feet and exceptionally low for this part of the Andes, does not provide a good route for a transandine railway, because two other ranges of equal height have to be crossed before the valley of the Marañon is reached.

Sea routes consequently play an important part in communication between one part and another of those countries whose populations are scattered along the coasts. Among these Brazil, Chile and Peru are the chief. The two first of these have now reserved their coastal traffic for ships of their own nationals, thereby emphasizing the importance they attach to this means of communication. In Brazil heavy goods make as straight as possible for the nearest port, even if they are destined for some other part of the country which, though lying at some distance, can be reached direct by railway. They then move along the sea-board till they come to a coastal point as near as may be to the place for which they are intended. In other South American countries also, besides those mentioned, coastal traffic is considerable. Thus the hinterlands of a number of small ports in Argentina, together with the Rivadavia petroleum field, are all brought within the orbit of the trade centre in Buenos Aires; and similarly in Venezuela the produce of a number of districts facing the Caribbean Sea, including the coal from the Barcelona field in the east, is concentrated coastwise in two or three leading ports. Ever since Europeans reached the New World, ships have played an important part in the conquest and development of the central and southern parts. It was by means of ships that Francisco Pizarro bridged the gap between Panama and Peru; and by sea as much as by land was the independence of both the Spanish and Portuguese colonies in South America won.

Railways began in South America in much the same way as in Australia, namely as isolated lines acting as feeders to a number of ports. Representing, as they did, a number of totally distinct undertakings, generally under foreign management, no thought was taken to secure uniformity of gauge. Now that many of the lines have extended so far as to link up with one another, the multiplicity of gauges simply aggravates the hindrances caused by physical obstacles standing in the way of establishing an efficient transport service throughout the continent as a whole. Out of a total of some 90,000 kilometres in 1926, rather more than 50 per cent. was metre gauge, about 27 per cent. broad gauge (5 feet 6 inches), about 10 per cent. standard gauge, and the remainder of miscellaneous gauges, mostly narrow. A striking example of the disadvantages of different gauges is afforded by the fact that the heavy exports of coffee from the State of São Paulo in Brazil have almost all

to be transferred at São Paulo city from metre gauge lines that serve the plantations to the broad gauge lines to Santos or Rio. Uniformity, however, is being aimed at in various republics as far as concerns new construction. In Bolivia the metre gauge is compulsory on all main lines, and the same gauge is in use on the state lines in Argentina and in Brazil as well as on most of the privately-owned main lines in the latter country, other than the very important loop Rio-São Paulo-Santos.

Owing to the inadequacy hitherto of the roads and the lack of navigable rivers serving the populous parts of the continent, railways have tended to be the chief means of internal communication. As soon as a railway is constructed, the rough mule tracks that have been used perhaps for centuries become largely disused, and the traffic is transferred to the railway. In some parts of Brazil, it is said, the routes followed by the old trails can be traced by the ruins of the villages which once lined them.

Since the first Great War the people in all but one or two backward republics, having turned from extreme dependence upon foreign trade to the all-round development of internal resources (see p. 52), have recognized the fundamental importance of railways and roads in implementing this policy of economic integration. From 1920 onwards almost all the extensions of the railways have been financed out of state funds, and since 1940 immense resources have been assigned to the construction of trunk highways and subsidiary roads. The central governments have been impelled to undertake these works for several special reasons; for in the absence of efficient means of transport there is a tendency towards political disruption among population groups scattered over large territories in diverse geographical regions, areas that are economically complementary to one another remain separated, and the margin of internal colonization is restricted. Moreover, the rapid industrial development since 1939, notably in Brazil, Argentina, and Chile, has necessitated the construction of roads and railways for the assemblage of raw materials and the distribution of finished products.

Down till quite recently each country has had enough to do to think of railway construction within its territory, without troubling much about the problems involved in linking up its railways with those of a neighbouring country. Some international lines are already open to traffic, however, and various others are in sight.

The first of them was the Argentine-Chilean Transandine, but this has been liable to interruptions for through traffic, and there are changes of gauge at Mendoza on the Argentine side

and at Los Andes on the Chilean. The route is therefore not of much service except for the carriage of passengers and of mails. Another international connection has been made between the Brazilian lines on the metre gauge in Rio Grande do Sul and the Uruguayan lines of the standard gauge. No regular time-table is worked over the combined system, and there is no great saving of time even for passengers travelling by rail from Rio de Janeiro to Montevideo as compared with the sea route. Bulky goods in any case, as pointed out above, would be dispatched by sea wherever possible, even between places much nearer each other than the two capitals. This link between Brazil and Uruguay is not really an international line so far as traffic is concerned. It has come into existence simply by the growth of the two national systems towards the frontiers of their respective states. The Madeira-Mamoré line, on the other hand, though as yet confined entirely to Brazilian territory, was constructed distinctly as an international affair. In exchange for a territorial adjustment in favour of Brazil, the railway was built to give the produce of the northern Bolivian lowlands an outlet to the Amazon navigation below the Madeira rapids. The full programme here includes the bridging of the Mamoré and the extension of the railway to Riberalta. There is not much prospect, however, of this Bolivian addition being made. A fourth international line links Asunción with Buenos Aires. The Argentine-Mesopotamian lines were built on the standard gauge, and on their reaching Posadas, the Paraguayan system was re-laid to the same gauge. This combined system is a serviceable through route, for trains are run regularly between the two capitals, though they have to be ferried over the Paraná at Posadas and again at Ibicuy above Buenos Aires.

Three other international railways in South America call for comment, namely those uniting the Bolivian Plateau with Pacific ports. The first of these to be constructed was the Antofagasta and Bolivia via Calama and Uyuni. Originally a narrow-gauge line, this was later relaid to the metre gauge of the Bolivian railway Uyuni-La Paz.¹ The two remaining railways connect La Paz, one with Arica by a direct route, and the other with the Peruvian port of Mollendo, via the steamer service on Lake Titicaca, the whole of this last route being worked by the Southern Peruvian Railway.

Several further links between the railways in different South American countries are under construction or are shortly to be started. That uniting the Argentine and the Bolivian systems via Atocha and Tupiza was completed in 1926. As the Argentine

¹ The Antofagasta and Bolivia Railway now operates the whole route

line to La Quiaca on the frontier is the same gauge as that of the Bolivian lines, through services are possible. Incidentally, of course, there is now connection all the way from Buenos Aires to both Arica in Chile and Mollendo and Cuzco in Peru. It is interesting to note that the route that is being followed here is that of the old colonial overland route from Cuzco to Buenos Aires via the Humahuaca quebrada.

Two other transandine lines between Argentina and Chile are constructed or projected. That in the south, the Lonquimay, via the Pino Hachado Pass or the Mallin Chileno Pass, at a maximum height of approximately 6,000 feet, is to link the Chilean longitudinal line with the Argentine line from Bahia Blanca at Zapala, the present terminus (see Fig. 50). The whole railway will be on the 5-foot 6-inch gauge, will cross the mountains by a comparatively easy route, and is assured of a considerable amount of traffic, at all events eastwards. The Chilean Government is anxious to have the line completed owing to the outlet it will provide for coal and timber from its southern provinces; the construction of the link, now in progress, may be completed in the near future. The northern transandine line, completed in 1946, links Salta with Antofagasta via Rosario de Lerma and Socompo. This long route, traversing the arid puna region, is an extremely difficult one owing not only to its high elevation, but also to the succession of ranges on both the Argentine and the Chilean sides. Though the Chileans at one time considered this railway of doubtful advantage because of the competition it would introduce in the supply of agricultural produce to the nitrate fields, the unsatisfactory external markets for South American exports since 1929 have caused Chile and South American countries generally to expand their trade with their neighbours. Argentina, on the other hand, has long been anxious to have this railway completed, particularly for the transport of cattle which hitherto have been driven with heavy losses over the mountains. For general traffic, e.g. in fertilizers eastward and cotton westward, the railway provides a direct link instead of the long sea route by the Magellan Straits.

It has been observed that transcontinental lines from east to west across the wider parts of South America can never have the same reasons for existence as the transcontinental railways in North America. The routes are immensely more difficult, and there cannot be the same interchange of products between eastern and western zones. Perhaps the most serious obstacle for the present and for some considerable time to come, is the subdivision of territory under different countries in a way that is quite absent in the northern continent. Under the existing

conditions countries such as Bolivia are unwilling to have their outlying parts connected by rail with neighbouring countries, before these are linked with the main centres of population and political power in their own territory. However, the Brazilian line from São Paulo to the border at Corumbá on the Paraguay has been extended to Santa Cruz in Bolivia, which will eventually be connected with the Bolivian Plateau system either indirectly via Embarcación or directly by the Rio Grande Valley. This route is the only one along which a transcontinental railway across and entirely within tropical South America is likely to be completed within measurable time, for the Brazilian section crosses the Paraná at the lowest point at which it can conveniently be bridged and farther north not only does the continent become wider, but once the great watershed between the southward and northward flowing rivers has been passed, the succession of giant Amazonian tributaries trenched in deep valleys much below the general level of the uplands, makes any east and west route almost impracticable.

It happens that three different countries occupy territory across the middle part of South America between 10° and 22° S. and four between 22° and $27\frac{1}{2}^{\circ}$ S.; and nationalist movements compel those of them whose territory extends from the highlands into the interior to make attempts to attach the population and the trade of their respective interior zones to the more settled plateau regions by means of railways. This, however, is opposed to the natural orientation of those lands, which find their easiest outlets either southwards by way of the Paraguay and Paraná Valleys to the Rio de la Plata or northwards to the great transverse highway of the Amazon. The tendency at present is rather towards Buenos Aires than towards Pará or Manaos, partly because tropical regions are complementary to populated temperate ones and partly because the ports on the Lower Uruguay and the River Plate have gained an enormous ascendancy as markets for cattle, which are the chief product of the occupied parts of the interior. The Northern Argentine railways have already reached the Chaco region and are being pushed on to the Pilcomayo. A branch from one of these northern lines is in course of construction to Yacuiba, just inside the frontier in Eastern Bolivia (see Fig. 28), and if petroleum is found in payable quantities farther north, the railway will be extended towards Santa Cruz and so bring the region within reach of Buenos Aires just as Eastern Paraguay has already been.

A survey of the railways of South America shows that only two important sections of the continent are as yet served by a network approaching that in existence in the eastern half of

North America. These two regions are the Argentine Pampa and the State of São Paulo in Brazil. Railways have been easy to construct owing to the comparative flatness of the Pampa on the one hand, and of the coffee-producing districts of the plateau on the other. When it is recollected that the mileage of good roads in the entire continent is comparatively small, it becomes clear that as regards overland transportation South America is still much behind the other continents occupied by Europeans, account being taken of the length of time since it was first settled by them, and of the population it now holds.

Since both the Amazon and the Paraná-Paraguay were navigated by Spanish explorers early in the sixteenth century, it appears strange that neither of these systems has developed into an important arterial highway, at all events for the territories up to the middle part of its course. The Amazon, it is true, is used by ocean-going vessels as far as Manaus and even to Iquitos in Peru, and the Madeira to Porto Velho towards the frontier of Bolivia; but the amount of traffic that is carried is very small in proportion to the area and resources of the basin. The great obstacle to the fuller use of the Amazon navigation is the fall line that crosses the lower courses of all the great south bank tributaries except the Madeira shortly before they enter the main stream (see Fig. 13). Vast areas of savannah country in the interior of Brazil, which would otherwise find an outlet by the Amazon, remain isolated and undeveloped. The Madeira, though navigable from its confluence with the Amazon for some 600 or 700 miles, drains densely forested equatorial lowlands which cannot attract settlers and whose only product has hitherto been wild rubber, and the same is largely true of the only large northern tributaries, namely the Rio Negro and the Japura.

The Paraná and the Paraguay have both been used in a limited way as a means of bringing products from the interior. For over half a century regular services of steamboats have been working on them. The Paraná, however, in its course through Argentina between the mouth of the Paraguay and Santa Fé city is difficult to navigate. It has a marked annual flood, so that suitable landing-places on its generally low banks are hard to find; and its channels are apt to change owing to the rapidity with which sandbanks are formed, swept away, and re-formed elsewhere. Navigation on the Upper Paraná is impeded by ledges of rock that cross the river just below Posadas and is completely interrupted by the La Guayra cataract higher up. Neither the Upper Paraná nor the Paraguay has been as fully utilized for commerce as might be expected owing to the fact that much of the courses of both rivers lies between two

different countries. In this respect the Paraná has suffered more because of the rivalries and the jealousies between the Spanish and the Portuguese colonists on either bank. Steamer communication on these rivers down to Santa Fé has not been successful in providing a satisfactory service, which has been, and still is, infrequent, exceedingly slow, unpunctual and unreliable. Now that the railways both from Eastern Brazil and from the ocean gateways of the Pampa have begun to reach the territories in the upper basins of these rivers, they compete severely with the rivers for traffic, and appear to be about to relegate them to a minor place as highways, just as the railways have robbed the Mississippi of its commercial importance in North America.

No railway has as yet been constructed to circumvent the obstacle of the Salto das Sete Quedas, or Guíara Falls between navigation on the Alto Paraná in Brazilian territory and that on the great stretch below them to the sea; but short railways of this kind have been built elsewhere in South America, and the obstructions to commerce on several quite important streams thus partially overcome. The Dorada Railway in Colombia, 72 miles in length, was built from Honda below the rapids on the Magdalena to Ambalema above, and has since been extended to connect with the Bogotá-Girardot-Ibagué railway, thus avoiding the stretch of steamer navigation between Ambalema and Girardot, since for some unascertained reason the level of the river has been falling. Bogotá has railway connections with the Magdalena both at Honda and at Girardot.

The short line from Puerto Colombia and Cartagena to points above the shallow distributaries of the Magdalena delta ¹ serves precisely the same purpose as lines round falls, namely that of providing a continuous transport route with the river for heavy traffic as well as for passengers. A railway, 72 miles long, formerly operated by the Great Western of Brazil, has been built round the Paulo Afonso Falls on the São Francisco between Piranhas and Jatoba. The difference in levels between these two points is 650 feet, but unfortunately there is a further section of shallow water and rapids above Jatoba which can be navigated only by small vessels. The great stretch of navigation on the Upper São Francisco tends to find its lower outlet through Juazeiro by the railway to Salvador. The Madeira-Mamoré Railway round the rapids on the Madeira has already been mentioned. It is estimated that if it is completed as originally proposed to Riberalta on the Beni, a vast territory

of 300,000 square miles in the basins of the headstreams of the Madeira will become accessible from the outside world.

The great difficulties of internal communication in South America have for four centuries and more made heavy demands on the none too abundant labour forces available. It is estimated that the Spanish Viceroy's caused the destruction of millions of Indians in the task of removing gold and silver from the mines in the Andes, and something of the same kind has been going on ever since their time. At the present day it requires about half the labour employed in the Yungas of Bolivia to transport the coca leaves, cane spirit and a few other products of that region to the Plateau. In view of these facts the release of labour arising from the extension of railways and the growth of road motor and air transport in South America must be very great, greater perhaps in proportion to area than in any other self-contained region in the world.

The importance of the sea as a highway between different parts of certain countries in South America has already been described. It follows also that the sea-borne traffic between the various republics bears a very high proportion to the whole of the limited trade between them. In this direction the opening of the Panama Canal has been of additional service. The great canal has had profound effects also upon the commercial relations between the whole western strip of the continent and the outside world. The Pacific region as far south as Northern Chile has been brought within easy reach of the North Atlantic basin, and this part of the continent which was formerly more or less isolated, is beginning to feel strongly the vigorous commercial influences of Western Europe and of North America. Incidentally, of course, it is now nearer to the United States than to Europe and more and more of its minerals and of its specialized tropical products are finding their way thither, while American capital and American manufacturers are quickening its economic life after a century and a half of stagnation. The Straits of Magellan have lost some of their former importance as a commercial highway with the opening of the Panama route,¹ and the region round them is likely to develop in the future simply as one of the world's outlying sheep-farming areas. The great shipping routes by way of the Panama Canal at the north-western corner, and along the comparatively short line from Europe to the east and south-east of the continent, constitute an important factor in the active development now in progress

¹ Just as the rivers act as some check upon the railway freights, so the Straits of Magellan route provides a safeguard against overcharges on, and an alternative in the event of closure of, the Panama route.

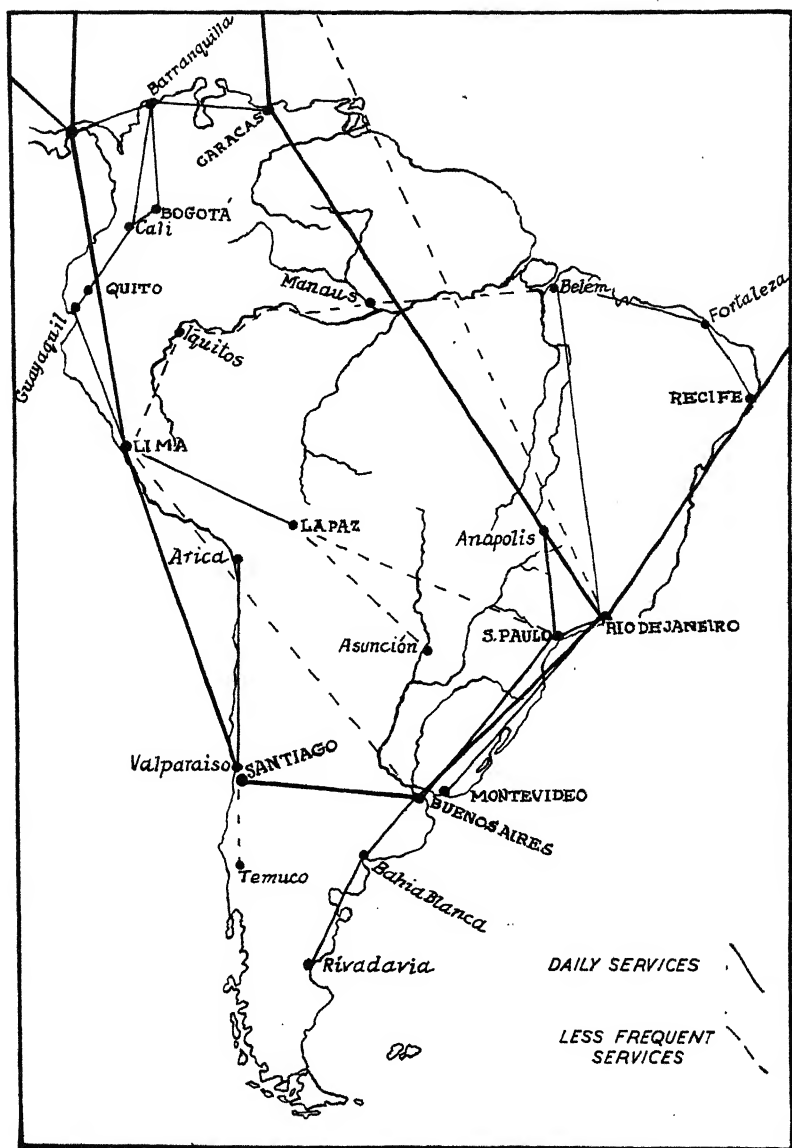


FIG. 10A.—South America: Routes of Air Services in Operation 1955

in these opposite sections of South America ; at the same time the North-East and the South-West are comparatively neglected, the former because of widespread tropical wildernesses and the latter because of remoteness from the world's commercial highways.

From 1930 onwards, and especially since 1940, air transport has been much developed in South America, where the peripheral pattern of settlement, the great distances separating population groups, and the physical obstacles to surface movement except by sea make this form of transport of special service. In keeping with the Pan-American policy and under the leadership of United States air transport enterprises, two main international routes are operated between the United States and the Argentine and Chilean capitals : the western line via Mexico, Central America, and the Canal Zone links Guayaquil, Lima, and Santiago with Buenos Aires ; the eastern lines via Cuba and Caracas (alternatively via Trinidad) provide services between eastern North America, the Caribbean area, Rio de Janeiro and the southern cities. Another important service operated by a British corporation connects these two southern capitals with Britain and Europe via Natal, Bathurst, and Lisbon. A fourth important international service is the so-called diagonal Pan-American from Lima by La Paz and Corumbá to São Paulo and Rio de Janeiro.

Of greater importance in the integration and development of the individual republics are their internal air services, mainly under some form of state control, which in addition to providing connections between the chief towns, help to bring hitherto isolated places into contact with the active centres. These internal services are best developed in Brazil, a country of great distances and generally poor means of surface transport ; they are also well established in Argentina and Chile, in both of which marginal northern and southern settlements are distant a thousand miles or more from the capitals, as well as in Colombia, Peru, and Bolivia, in all of which high cordilleran ranges present great obstacles to ordinary transport between eastern and western regions.

Though employed mainly for the carriage of passengers, mail and newsprint, these national air services are of special value, and are being developed for the transport of goods, not only of the lighter and relatively valuable type, such as medical supplies and spare parts, but also of bulky articles, e.g. heavy machinery. Inasmuch as indifferent means of transport have been a serious obstacle hitherto to economic development, the importance of air

CHAPTER V

TROPICAL PLANTATION CROPS—THE TROPICAL COASTAL LOWLANDS

A. The Tropical Products of South America

A CONTINENT, a larger proportion of the area of which lies within the tropics than of any other, naturally occupies a prominent place as a source of such tropical products as cacao, rubber, cane sugar and mandioca, and of sub-tropical products such as cotton, coffee and rice. Moreover, the cacao tree, the *Hevea* and various other species of rubber-producing trees and shrubs, the mandioca plant and a perennial species of the cotton family, are all indigenous to South America. The tropical section of the continent is also the original home of the cinchona tree, yielding quinine and found growing wild on the eastern slopes of the Andes. In addition to these there are several other commercially useful plants, natives of tropical South America, among them the carnaúba palm and the ipecacuanha plant, that have not been acclimatized elsewhere.

While South America produces far more coffee than any other continent and ranks next to Africa in the production of cacao, its output in most of the other products mentioned above is relatively small. Large areas of land possessing both fertility and a suitable climate are available in the immense tropical area of South America for the cultivation of sugar cane, cinchona and rubber, but the labour required for clearing the ground of forest and for planting and tending these crops is notably deficient. The tropical lowlands of the continent never carried a dense native population such as those of South-Eastern Asia. The sparse Indian population which the Europeans found scattered over these lowlands on their arrival, lived in a most primitive fashion, and showed no aptitude for civilization or inclination to productive labour. They have accordingly continued to live on the same low scale of civilization as they did before they came in contact with white men. Whatever labour force they have been induced or compelled to supply has always been of the most meagre. Till recently also, the Spaniards and to some extent the Portuguese settled in the New World have despised

agriculture. In the tropical parts of Central and South America, mining for precious metals claimed foremost attention from the invaders, and those who did not join in the search for gold and silver, took to stock-rearing as the next best. Thus the potentially fertile forest-covered lowlands held by the Spanish and Portuguese were left severely alone by them, except for the cultivation of sugar-cane on a small scale in Brazil, and those enterprising Europeans of other nations who wished to find tropical lands for the cultivation of sugar, spices and other similar products, had to settle in places not occupied by the Iberian powers. To do the latter nations justice, however, it must be admitted that not only are the tropical lowlands of South and Central America, in common with similar regions elsewhere, generally unhealthy for Europeans, but the task of converting these lowlands from their natural state into productive plantations and fields is greater than in most other parts of the tropics. Faced with great natural obstacles and without any reliable supply of native labour, the European in the hot lowlands of South America is, as it were, a head without the body; he must either lapse into an unenterprising vegetative existence or must go elsewhere. It was a sound instinct that caused the early Spanish and Portuguese settlers in South America to seek the highlands beyond the coastal belts of tropical forest. There at least they enjoyed a healthier climate, even if they were still more cut off from the outside world. There, too, the forest gave way in places to grasslands which could immediately be utilized with a minimum of labour, and there also, they often found a denser and more industrious native population which could be drawn upon for labourers. The difficulties of the labour situation in tropical South America are well illustrated by the small progress made in British Guiana which has been held by Europeans for upwards of three centuries. It is true that sugar cane is cultivated to a limited extent in that colony along the coastal lowland strip, but not with the assistance of local native labour. After the emancipation of the negro slaves, the labour shortage became acute, and the cane plantations were saved from complete disappearance only by the importation of coolies from British India.

So far as the supply of labour is concerned, the descendants of the emancipated negroes, who are fairly numerous throughout the northern and eastern coastal sections of the continent, are of little account. They live under squalid conditions, they work as little as possible, and they apparently spend most of their time in childish amusements. The most important element in the working population of all the northern part of the continent is supplied either by the plateau Indians, as in the Andean

highlands, or by people of mixed Indian and European descent, who also contribute an important part of the labour force in the Andean region. Elsewhere in tropical South America with some exceptions, these native Indians and mestizos, together with negroes on the coastlands, perform much of the manual labour. The rubber forests of the Amazon region, for example, have been worked largely by labourers of mixed blood from Ceará and other states in the upland region of North-Eastern Brazil, which, especially in times of drought, have been able to supply numerous labourers to other parts, after meeting the requirements of their own stock-rearing industry.

In the exploitation of their tropical resources, none of the South American states has been able hitherto to organize production on large-scale labour-saving lines, as, for example, the Americans have in the cultivation of sugar-cane in Cuba, or as the British have in the planting of rubber in Malaya. The nearest approach to this modern form of efficient cultivation of tropical crops to be found in South America under the control of South Americans is represented by the coffee-growing industry of Southern Brazil which has several peculiarities from the economic standpoint and concerning which more will be said later. It is significant that the only attempt at establishing a modern large-scale plantation industry in the northern part of South America should be due to foreign enterprise. The United Fruit Company, a North American concern, owns extensive banana plantations in the Santa Marta district of Colombia equipped with the latest devices to ensure quick loading with fruit at exactly the right stage of maturity into their specially constructed steamers which make regular connection between the Caribbean shore and the ports on both sides of the North Atlantic.

A further disadvantage under which the tropical regions of South America suffer is a shortage of capital. During the three centuries of Spanish rule little was done in the way of permanent development. On the contrary, the object of the home country was to get as much as possible out of the colonial empire, no matter at what cost to the possessions overseas. No resources were expended there except what were absolutely necessary to get a quick return. When the South American peoples broke away from Spain and Portugal early in the nineteenth century, they inherited nothing in the way of material values from their former rulers except what was left of the natural resources. Nor were Spain and Portugal in a position, as Great Britain was in North America, to lend large, or indeed any, sums of capital to the South American republics for their development. In view

of the great and varied natural resources of almost all the states in South America, it might appear that they should have been able to accumulate stores of capital independently; but the heritage of the period of European rule lay like a curse upon the new countries of the southern continent. Spanish rule was highly centralized and Portuguese rule, though less autocratic, was more so than the British has ever been. The people of South and Central America accordingly remained ignorant of the methods and problems of government, and having gained their independence, they took upwards of a century to settle down to stable self-rule. One or two of the more advanced republics reached stability well before the close of the nineteenth century; some of the most backward have scarcely achieved it yet. Thus, while other outlying continents, notably North America and Australia, were developing rapidly under efficient self-government that offered security for the investment of European capital, South American republics as a whole were occupied with political problems and struggles which bore as their fruit only too frequent revolutions. Till these became the exception rather than the rule, foreign capital found other fields for investment, and there was little inducement for those in South America who had surplus income, to save it except by investing it in real estate. A premium was consequently put upon the ownership of land and upon lavish expenditure. Neither of these, when they come to be regarded as socially desirable, as has been unfortunately too much the case in South America, is favourable to the accumulation of productive capital, to enterprise in the people, to commercial activity, or to the development of latent resources. South America is potentially rich, but it carries a smaller population than any other continent except Australia, and throughout the whole tropical section the average *per capita* wealth is still very low.

Owing partly to the sheer physical difficulties, partly to the shortage of labour and partly to lack of organization, tropical South America has made relatively poor progress with the exploitation of some of its leading resources. The Amazon basin, the natural home of the rubber tree, cultivated elsewhere, has sunk to a minor place as a source of commercial rubber. The cultivation of cacao seems to be following that of rubber to other continents. Brazil and the three north-western republics of South America, formerly with the West Indies almost the sole sources of cacao in world trade, now together produce little over half as much as the Gold Coast and Nigeria in Africa, and this relative decline has occurred in the last sixty years. Scarcely any quinine now comes from the Eastern Andes whence

it first became known to the world. Though vast areas in South America are suitable for the cultivation of cotton, total production and exports are relatively small¹; only Brazil and Peru have a significant surplus above local consumption. The coco-nut palm grows wild along the sandy shores facing the Caribbean and the Atlantic all the way down to Rio de Janeiro, a distance of some 4,000 miles, but scarcely any effort is made to tend the trees or to establish plantations, while something over a million tons of copra are exported from other tropical parts of the world to the markets of the North Atlantic.

The coastal lowlands of South America in the tropics have, however, been an important source of certain tropical products for several centuries, and their economic life at the present day is based on tropical agriculture together with a very limited timber-cutting industry. This region will now be described in detail.

B. The Tropical Coastal Lowlands

The tropical coastal lowlands of South America do not correspond in extension along the shores, with the tropical zone as defined by latitude. On the west, owing to the influence of the cold current, they do not reach beyond the southern border of Peru at 18° S., and on the east they extend beyond the Tropic of Capricorn to about 27° S. Within these limits, however, right round the northern part of the continent, the lowland belt stretches with certain interruptions for a distance of some 7,000 miles. Its width varies considerably, but in proportion to that of the continental mass is always narrow. In the delta region of the Amazon and eastwards into Maranhão it is upwards of 300 miles wide, while on the plains at the mouths of the Orinoco and the Magdalena it reaches inland at least 200 miles. It has, moreover, numerous bays where it is of greater than average width extending up the valleys of other smaller rivers, in particular in Eastern Brazil and in the neighbourhood of the Gulf of Guayaquil. Along the rest of the coast it is generally only between 10 and 50 miles wide, and in places along the Peruvian and Venezuelan coasts, as well as along the east coast of Brazil south of Rio de Janeiro, it is very narrow or non-existent.

Except in the deltas of the great rivers the coastal strip is by no means uniform as regards either its surface or the character of the soils and vegetation. The flat shoreline strip, as in the restingas of Eastern Brazil, is generally more or less sandy, is covered, even where moisture is abundant, with a somewhat

¹ See, however, the account given p. 198 below of the prospects for cotton-cultivation on the Chaco.

scanty vegetation in which coco-nut palms predominate, and is often backed towards the land side by an ill-drained, swampy tract in which lagoons are occasionally found. Behind this wet zone lies the most important belt of the coastal lowlands, consisting as a rule of rich alluvial soil and covered in its natural state, where the climate is favourable, with tropical forests. This is the *matta* region of Eastern Brazil. It runs inland up the rivers and even extends over the first low hills. In fact, it is the varying width of the moderately hilly belt that is mainly responsible for the changes in width of the whole coastal zone. The undulating country, however, gives place almost everywhere from Southern Peru to Southern Brazil, to mountains or plateau country of considerable height, steep towards the sea, so that the inland limits of the lowland strip are clearly marked.

The climatic conditions in different parts of these peripheral lowlands vary considerably, as will be clear from the account given in Chapter II above. The rainless section in Peru is followed in the north-west by another section extending from the Gulf of Guayaquil to Panama, in which there are abundant tropical rains and where forests descend to the Pacific. East of Panama as far as the Orinoco Delta the rainfall, though fairly heavy, is distributed seasonally in such a way as to favour savannah vegetation where the dry intervals are long, and to permit of forests where they are short. These conditions continue into the coastal margin of the Guiana Plateau and beyond to the Amazon Delta, but with an increasing proportion of the area under forests. Marajo Island at the mouth of the Amazon, however, is mainly savannah country. From Pará to the mouth of the São Francisco, the coastal strip is fairly well supplied with rains, but at the north-eastern angle of the continent these share somewhat in the uncertainty of those of the inland districts, and the natural vegetation is accordingly patchy. True forests occur only on the elevated and exposed areas. Along the coast to Bahia and thence onwards to Paraná State, the alluvial lowlands and the seaward slopes of the hills and mountains were originally covered in the main with a luxurious tropical vegetation favoured by the abundant rainfall distributed throughout the year.

The coastal district of Peru produces little or no vegetation except along the valleys of some forty or fifty streams that descend from the Andes, of which only about thirty are of importance for cultivation.

A number of these streams rise in the main range of the Maritime Andes, the highest peaks of which are often covered with snow, so that they are assured of a regular supply of water.

of the country. In some parts, in particular in the neighbourhood of Lima, the valleys are close together, but in others they are separated by as much as 70 miles of desert.

In Ecuador and along the shores of Colombia there are extensive swampy tracts near the mouths of the four main rivers, the Magdalena, the Atrato, the S. Juan and the Daule, in which mangrove forests predominate and which are useless for cultivation. Elsewhere moderate uplands rise beyond a narrow coastal strip and the slopes and the valleys of these are utilized extensively for the production of cacao, bananas and similar crops of the inner tropical zone. The same disposition of the relief occurs in Northern Venezuela, except that in the central section mountains take the place of hills and rise more abruptly from the sea. In some of the drier valleys of Western Venezuela coffee is grown as the cash crop rather than cacao.

The coastal lowlands through the Guianas to the delta of the Amazon and again from Maranhão to the mouth of the São Francisco consist of a succession of sandy tracts and rich alluvial formations. Where the soil is fertile, tropical cultivations have been established, among which much the most important are sugar fields; and these, except for cacao plantations in the Ilheus district south of Salvador, predominate all along the tropical eastern coast of Brazil.

For some distance north and south of the lower course of Rio Doce the country is covered by swamps and lakes, and a similar water-logged area, but not so large, occurs at the mouth of the Parahyba some distance to the south. Above its ill-drained delta region, however, this river has a broad valley originally forested, but devoted for a long time past mainly to the cultivation of the sugar cane. The narrow coastal plain in São Paulo and Paraná is inclined to be swampy, and is utilized in favourable places for the cultivation of rice, bananas and similar tropical crops.

The well-watered parts of the tropical lowlands along the coasts of South America offer one striking contrast with the rainless section in Peru: whereas in the latter almost all the productive land is occupied, in the former only selected portions, amounting in all to a fraction of the whole, have been brought under cultivation. The luxurious tropical forests have been a serious obstacle to development, and the settlements tend to concentrate in those sections where the forest is thin or absent, the rainfall less, and the land naturally well-drained. The annual average temperature throughout the whole belt from Northern Peru to Santos in Brazil approaches 80° F., and the heat combined with abundant moisture makes the climate enervating for Europeans and in many parts unhealthy. The

ease with which it is possible to grow such staple foods of natives and negroes alike as mandioca and bananas, has rendered it difficult to get much work from either of these races except under compulsion, and the days of enforced labour are over even in Brazil. Such conquest of these tropical shore-lands as has been effected by man, has been at great cost in life and labour and has been singularly incomplete.

Two circumstances, however, have co-operated to concentrate settlement and attention on these lowlands in spite of their manifest disadvantages. First, being next to the sea, they have been the key to the interior regions : in the early days of colonization it was advantageous to populate them and establish garrisons in them for military reasons ; and more recently, with the opening up of the hinterland by means of railways, the ports along the coast have become ever greater gateways of commerce. Second, since the earliest European settlement of South America, these tropical coast-lands have been able to supply one product that has constantly been in active demand in Europe, namely sugar. For several centuries this and tobacco were almost the only agricultural products of the whole southern continent that found a ready market abroad. Small wonder, therefore, that more attention was given to the coastal lowlands than they appear at first sight to have merited.

Among the products of these lowlands at the present time sugar still holds a place of first importance in which it is rivalled by cacao. Among other products, to which, however, smaller areas are devoted than to either of the primary ones, are mandioca, cotton and rice. In discussing these commodities, it will be convenient to survey the conditions throughout the continent as a whole relative to the production of sugar and of cacao.

C. Leading Crops of Tropical South America, especially of the Coastal Lowlands

SUGAR

The cultivation of the sugar-cane has been established in South America for several centuries, whence it spread from the West Indies in the early colonial days. The most important region for a long time was the coastal belt of Eastern and North-Eastern Brazil, from the Tropic of Capricorn northwards as far as the mouth of the Amazon. To work the Brazilian cane fields large numbers of negro slaves were imported from West Africa from 1600 onwards, but especially during the early half of the nineteenth century. With the emancipation of the slaves, the sugar industry in Brazil received a set-back from which it

has never properly recovered, and it now no longer contributes any considerable supplies to markets outside South America. Cane-sugar is also produced in various smaller regions in the South American continent; in particular, in the Argentine provinces of Tucumán and Jujuy, in the irrigated valleys of Western Peru, in the eastern part of the State of São Paulo and Rio de Janeiro in Brazil, and in various scattered districts along the northern shores, from the Guianas to the Isthmus of Panama. However, the combined output of all these regions, including the first, is little more than sufficient to meet the requirements of the continent. Several republics—Uruguay, Chile, and Bolivia—produce little or no sugar, and three others, Argentina, Ecuador, and Colombia, while producing most of their requirements, have from time to time imported some supplies. Though the *per capita* consumption of sugar throughout the continent is apparently low, that of spirits made from sugar is relatively high. Be that as it may, the small surplus available for export abroad, when the needs of the continent have been met, is not due to a heavy internal consumption, as compared with North America or Western Europe.

Such as they are, the various sugar-growing regions of South America each possess some features of interest. Their relative importance appears from the table below, showing the approximate average production in thousand tons for the years 1953-54 and 1954-55.

Brazil	2,266	Colombia	223
Argentina*	744	Trinidad	186
Peru	597	Venezuela	79
British Guiana	256	Ecuador	70

* Argentine production tends to fluctuate owing to occasional frosts in Tucumán (see p. 211). Production, which amounted to over 540,000 tons in 1940, fell to under 363,000 tons in 1942, but rose to 636,000 tons in 1951, and to the record of 778,000 tons in 1954.

The sugar region of North-Eastern Brazil extends along the coast all the way from Rio de Janeiro to Maranhão, but production is greatest in Bahia and Pernambuco. Other states in which the cultivation of the sugar-cane is one of the leading industries are Sergipe, Alagoas and Paraíba. For successful cultivation the plant requires a fertile soil so that the plantations in this region tend to concentrate on the alluvial lands along the lower courses of the rivers, or on lands that have been built up by rivers elsewhere between the foothills of the plateau and the sea. The narrow coastal plain almost everywhere receives a fair rainfall, though the inland districts suffer from general dryness and from periodic droughts. In the extreme north-eastern states, however, the rainfall even on the coastal strip is apt to be insufficient

for the heavy requirements of the cane, and there the plantations are more or less confined to the low-lying margins of the rivers. In these states the methods of cultivation, and especially of extraction of the sugar from the cane, are said to be somewhat primitive. The industry is split up into a number of separate small undertakings, each producing raw sugar with more or less obsolete plant. Small progress has as yet been made towards the organization of the industry round properly equipped works. It is not difficult to understand how the fazendeiros, as the plantation owners are called, feel the competition of sugar produced in vast quantities at a minimum cost per unit in Cuba and other parts of the world. The remedy for trouble of this kind that is most popular in Brazil is high protection. To some extent this is effective, for the Brazilian market is a very large one and is capable of absorbing much, but by no means all, of the product; in another way it is disastrous because it simply stereotypes the existing methods and discourages the introduction of such improvements as alone are capable of putting the industry on a sound footing. Further south in the States of Rio de Janeiro, Minas Geraes, and São Paulo there is more appreciation of scientific and economical methods in the sugar industry, as is only to be expected in a part of Brazil where manufacturing industries have recently made great strides; but the areas devoted to sugar-cane here are not yet as large as in the north-east.

Peru has been displaced by Argentina as the second largest sugar producer of the continent. In that country sugar is grown extensively in the irrigated valleys of the streams that traverse the dry coastal plain after descending from the high Andes, of which those of the Chicama (north of Trujillo) and of the Lambayeque and the Santa Catalina (near Pimentel) lead in production. As the population of Peru is much smaller than that of Brazil, about 10 millions against 61 millions, there is a larger surplus for exportation out of a smaller annual production; in fact, Peru is the greatest exporter of sugar among South American countries, most of the trade being with Chile, which produces only negligible quantities, entirely in the province of Tacna, belonging geographically, as it formerly did politically,¹ to the Peruvian coastal region. The tendency in the Peruvian valleys is for sugar-production to be conducted on fairly large estates, and to be concentrated for physical reasons in comparatively small areas. Thus advantage can be taken of the economies of large-scale enterprise utilizing modern methods and machinery. The expansion of the industry is closely linked with the extension of

¹ Under an agreement made between Chile and Peru in 1929 the northern part of this province has reverted to Peru.

rigation. At the best, and for some time to come, the output of sugar from the Peruvian region will expand gradually, as it has done in recent years. Though the harvests are safe from fluctuations owing to climatic vicissitudes, the limited area of irrigated land and the competition of other crops must make any large expansion of sugar production impossible.

The second leading sugar-producing region of South America is north-west Argentina in Tucumán, Salta and Jujuy Provinces. The geographical conditions affecting the industry there are peculiar and will be discussed at length in Chapter XVI below.

Along the northern coasts of South America the sugar-cane is cultivated in every political division from French Guiana to Ecuador, but the most important from the point of view of exports are the British Guiana and Trinidad. Colombia produces a small surplus above local requirements, while Venezuela and Ecuador can barely satisfy their home demands from their own resources. In the Guianas and in Trinidad sugar is systematically grown on estates mostly under the management of Europeans and worked with coloured labour. In these colonies the sugar industry has passed through hard times owing to the competition of European beet sugar and the bounty system. Now, once more, it has to face strenuous competition, this time from the highly organized plantations in the larger West Indian islands. As a consequence of the marked seasonal rainfall, sugar cultivation in Trinidad and on the mainland tends to reach its maximum development on the low-lying and somewhat swampy coastal strip where it meets with a certain amount of competition from rice-growing, particularly in British Guiana. There the climate is enervating for Europeans and by no means healthy, and this factor, combined with labour difficulties and the external competition above referred to, accounts in some measure for the comparatively small progress made during the long period since the industry was first established. In the three north-western republics foreign competition is not a serious matter, since very little or no sugar is available from them for export; but the industry stagnates there partly because any marked expansion would bring that factor into operation, more perhaps because of the internal competition for the limited supplies of labour available exercised by other forms of agriculture and by mining, which can generally be pursued in healthier and pleasanter surroundings.

CACAO

Cacao is produced in four of the South American republics, namely, Brazil, Ecuador, Venezuela and Colombia in order of importance; only the first two produce much in excess of local

requirements. In Ecuador the cacao-plantation industry contributes the chief item of agricultural products in the export trade, though the quantities supplied by that country are now relatively small. The average production of cacao beans in the chief producing regions in the two years 1953-54 are shown below.

	Thousand metric tons.		Thousand metric tons
South America :		Other Regions :	
Brazil	115.0	Mexico, Central America and West Indies . . .	37.6
Ecuador	26.6	West Africa	334.9
Venezuela	16.7	Ceylon and others . . .	8.6
Colombia	15.0		
Total	<u>173.3</u>	Total	<u>380.1</u>

The cacao tree differs from the coffee shrub with regard to climatic requirements. It needs abundant rains distributed fairly well throughout the year, a high average temperature without any marked fluctuations between summer and winter, and a deep and fertile soil. These conditions are most completely realized on river plains and in valleys in the neighbourhood of the sea, which are exposed to rain-bearing winds and are situated within the inner tropical zone between latitudes 15° N. and 15° S. Though cacao grows wild in the forests of the northernmost part of South America, when cultivated in open plantations it requires shade while the trees are small. For this purpose banana plants are used, so that it is possible to carry on the production of bananas together with that of cacao beans, the former crop being incidental to the latter. Since, however, bananas are much more difficult to transport than cacao, and enormous quantities grow almost wild in the whole Caribbean region, those grown on the cacao plantations are of little value except for local consumption.

Owing to its situation with reference to the Equator, South America has a larger zone suited to the production of cacao than any other continent. Beginning in the west, just north of the Gulf of Guayaquil, this zone extends over the Isthmus of Panama and follows the northern and eastern shore of the continent to the southern part of the Brazilian state of Bahia, a distance of some 6,000 miles. From this must be deducted some 1,500 miles of the coastal lands of the semi-arid region in North-Eastern Brazil, but by way of compensation an extensive area in the lower Amazon Basin should be added, for, though little cacao cultivation has as yet been practised in that region, there is little doubt that the conditions are highly favourable in this the original habitat of the tree. It is remarkable, therefore,

that the South American group, even including the island of Trinidad, should not now occupy the first place among the producers of cacao. The explanation is to be sought in the shortage of labour adapted to the trying climatic conditions, as compared with West Africa or even with the West Indies; for the cultivation and preparation of cacao for the market demands a considerable amount of careful labour and attention. It is noteworthy that the British island of Trinidad, which has a much smaller area available for cacao planting than any of the four republics on the mainland within the cacao zone, nevertheless produces upwards of 10,000 tons per annum.

With the rapid expansion in West African production between 1910 and 1940 a marked fall occurred in the prices realized for cacao beans on the international market. This hit South American producers, who are handicapped by lack of sufficient labour and of facilities for acquiring and applying scientific knowledge. The easy-going inhabitants of tropical South America seem bound to suffer, in one field of production after another, the penalties of failure to keep up with the times; either the industry in which they formerly enjoyed a position as major producers is established elsewhere under efficient methods and on such a scale as to flood the market and bring down prices, or, as has happened already in at least one instance, large syndicates backed by large supplies of capital will get a footing in South American territory, apply up-to-date methods to the exploitation of the resources, and retain the profits for themselves.

Minor Products of the Tropical Coast Lands

Mandioca is widely grown in tropical South America, on the uplands as well as on the coastal lowlands. Over large areas in Brazil and in the northern republics it forms a staple food of the population. Indigenous to the New World, it was used as an important article of diet by the Indians before the arrival of the Europeans. The plant belongs to the family known as Euphorbiaceæ, of which two varieties are used in South America, the sweet and the bitter. Of these the second is much the more important, but as the root contains a poison under the skin, great care has to be taken in washing the ground particles so as to get rid of this. After thorough washing the product is dried and then ground into a flour known in Brazil as farinha de mandioca, in which form it is distributed for domestic consumption and transported to non-tropical Latin American markets. In order to manufacture tapioca, an important article of international commerce, the washed product obtained from the roots is allowed to soak for some time in water vats, during which process the

starchy material rises and can be removed. The best varieties of roots are said to yield 16–20 per cent of tapioca. Owing to the widespread cultivation of this plant and of maize in tropical South America, the consumption of wheat is remarkably low. Hardly any is grown north of about 30° S., and very little is imported into the whole eastern area north of Rio de Janeiro. In Brazil, where mandioca is commonly grown in patches and fields attached to the dwellings of Indians and Europeans alike, the production of the flour is estimated at about a million tons annually. The absence of modern means of transportation and the high cost of carriage over the greater part of the interior tropical areas of South America make mandioca an eminently useful article in the food supplies of the population.

Cotton is one of the leading crops in the irrigated valleys of the coastal region of Peru, which, like the sertão region of North-Eastern Brazil, has long specialized in the production of cotton for export, though its output is smaller than that from this region. The Peruvian cotton-growing industry closely resembles that of the lower Nile in Egypt in that it is confined to valleys of rivers traversing a desert strip as they approach the sea. Several kinds of cotton are grown in Peru, a native variety of coarse fibre, and two special varieties, of which Tangüis, yielding a long, silky fibre, accounts for most of the exports. Of the valleys utilized for cotton-growing, nine are more important than the rest, namely those of Piura, Supe, and Huacho in the north, which get occasional equatorial rains, those of Cerro Azul and Cañete in Lima Department, and those of Ica, Pisco and Tambo in the south. The two last-mentioned are among the most productive, while the Ica valley grows little of the Egyptian variety owing to scarcity of water. Since the cotton exports of the country consist largely of the superior kind, their value is high in proportion to the quantities.

The cultivation of cotton in Peru is restricted by several rather serious factors. First and foremost, there is the shortage not of land, but of irrigated land, and the resulting pressure upon cotton-growing exerted within the limited cultivable area by the demands of other crops, in particular of sugar-cane. Then again, large estates are common and there are difficulties in obtaining adequate labour. In other important cotton regions—in the United States, in Egypt and India—much of the labour of cultivation and harvesting is supplied by the small farmers who work the land, while in Peru the large landowners have to rely upon the insufficient labour of local and Sierra Indians, since European workers are not likely to be attracted to a region where the climate is far from agreeable and in which there are no

prospects of independence. Moreover, the industry is necessarily very scattered, and thus lacks the technical benefits of compactness.

In many parts of the tropical and sub-tropical coastlands of South America, physical conditions are favourable for the cultivation of rice, but previous to 1940 Brazil was the only large producer. The tendency is to grow upland rice which, though less productive than swamp rice, requires less attention and succeeds in lands climatically suited to Europeans by reason of their moderate elevation. Since pre-war years production has greatly increased in each of the eight countries for which details are given below.

1,000 METRIC TONS OF PADDY

	Average 1934-38	Average 1954-55		Average 1934-38	Average 1954-55
Brazil . . .	1,365	3,773	British Guiana	70	160
Colombia . .	99	301	Chile . . .	11	77
Peru . . .	86	254	Uruguay . .	17	67
Argentina . .	51	168	Surinam . .	29	66
			Totals .	<u>1,728</u>	<u>4,866</u>

The remarkable expansion of rice cultivation in these countries during the twenty-year period, far greater than the increase of population, points to a redistribution of agricultural resources in favour of food crops at the expense in some measure of those produced mainly for export. It is an expression of rising standards of living and of the prevailing urge to self-containment, since exports of rice to countries outside Latin America are relatively small.

The coconut palm and various species of bananas both grow wild in the northern lowlands of South America. The former flourishes along most of the tropical shores, but especially in the Brazilian states from Maranhão to Bahia. Compared with the tropical regions of the Eastern Hemisphere, however, South America produces almost insignificant quantities of nuts.¹ The few that are exported from the continent are sent away whole, the copra trade being as yet unknown there. It is said that there are immense possibilities of expansion in the South American production of coconuts, but the establishment and the care of plantations await a denser population, greater supplies of labour, and more enterprising intelligence to direct that labour than the tropical lowlands at present possess.

¹ The world's production of coconuts is estimated at 7 to 8 billions per annum, of which some 200 million are due to the Western Hemisphere and perhaps 100 million to South America.

The banana has become an important article of fruit consumption in North America, especially the United States, and the Caribbean coastlands of South America, which are admirably

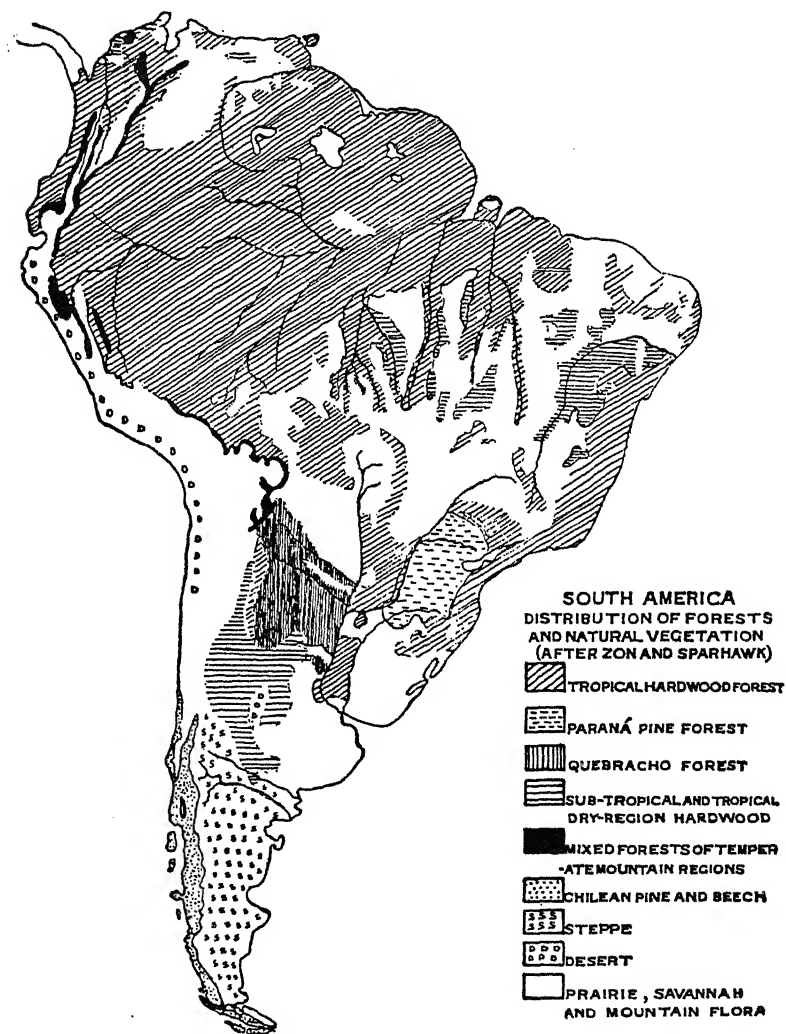


FIG. 12.—Forests and Natural Vegetation of South America

This map illustrates a number of sections dealing with forests and vegetation in the succeeding chapters

adapted to its cultivation, have begun to share actively in the production of this fruit. The United Fruit Company's plantations in the Santa Marta district of Colombia have already been

mentioned. These were highly successful until during the last war, which cut off the European market, they were attacked by disease. The future of the industry in tropical South America will depend upon the general conditions of demand as well as upon whether competing sources of supply, such as the West Indies, find they can devote their land and their labour to the production of more profitable crops.

The forest wealth of the coastal lowlands, though as yet little developed, is apparently considerable. The timbered sections extend along the coasts of Ecuador and Western Colombia, are interrupted by stretches of savannah and brushwood, amounting perhaps to about one-third of the total distance from Panama to Pernambuco, but, as above noted, extend thence practically unbroken down to Rio de Janeiro and beyond.

The most important products from these lowland tropical forests of South America have been tagua nuts from Ecuador and the Pacific coast of Colombia, tanning materials, such as mangrove bark and divi-divi pods, as well as mahogany from the Caribbean coast lands of Colombia and Venezuela, very durable hardwoods from the Guianas, such as greenheart and mora used in dock construction, and a variety of hardwoods, ornamental timbers, and dyewoods from Eastern Brazil. The accessible mahogany in the Caribbean forests has been worked for centuries and is now more or less cut over, but there are immense reserves of useful timbers in both the Guianas and in Eastern Brazil, especially in the Rio Doce valley. The timber that has been most sought in recent times is that of the Spanish Cedar, which is very widespread in the tropical forests of South America.

Contrary to the ordinary opinion, these coastal forests are by no means wild jungles in which there is a riot of species, for comparatively pure stands in which a few species predominate are of common occurrence; nor do the forests consist entirely of hardwoods, at all events in the Atlantic division of Brazil, for according to the most recent authorities typical stands in Bahia will furnish by volume 42 per cent of softwoods and 30 per cent of medium hardness. The proper exploitation of these tropical forests near the seaboard has been hindered by inadequate means of transportation, by wasteful and uneconomical methods of working everywhere except perhaps in British Guiana, and, above all, by the abundance of serviceable timbers till recently elsewhere, imports of which could be landed more cheaply at South American ports than local timbers could be brought there from places nearby.

CHAPTER VI

THE AMAZONIAN LOWLANDS AND THE MONTAÑA

THE lowlands of the Amazonian Basin, lying between the Guiana Highlands and the divide towards the Orinoco on the north and the Brazilian Plateau and the headwaters of the Madeira on the south, comprise one of the largest areas of practically unbroken forests in the world. To this great forested area the lower eastern slopes of the Andes naturally belong, for there is no break either in climate or in vegetation in ascending from the lowlands some 5,000 or 6,000 feet up the mountains.

Except for the elevated belt in the west, the whole region lies almost entirely under 1,000 feet above sea-level, and the greater part of it under 500 feet, while about 10 per cent of the lowland area consists of alluvial soils in the flood plains of the rivers and is so low as to be subject to periodic inundation. Throughout the middle and lower part of the basin, in point of fact, a clear distinction is observable between the partly consolidated material lying as a rule well above the flood levels of the rivers and known as *terra firme*, and the softer recent material liable to floods known as *varzea*. The boundaries of the former towards the rivers are marked by lines of bluffs that can be traced for great distances along the axial stream and along the courses of the great tributaries below their rapids. On these bluffs the scattered towns and settlements in Amazonia are almost always situated.

The true limits of the lowlands of the Amazon basin are marked by the uplands to the north and the south consisting of rocks ranging from Archean to Cretaceous. The distance between these uplands on either side reaches a maximum of about 800 miles along 68° W. and declines to a minimum of 150 miles in the longitude of Santarem. The true Amazonian lowland region is therefore spatula-shaped. Within this area of about 1.2 million sq. miles the greater part of the surface is the *terra firme* already noted, which consists of sands and clays apparently of Miocene to Quaternary age. Towards the mouth of the main river recent alluvial material is more abundant than elsewhere. Marajo

Island, for example, consists entirely of this type of deposit in its western half, the eastern part being terra firme.

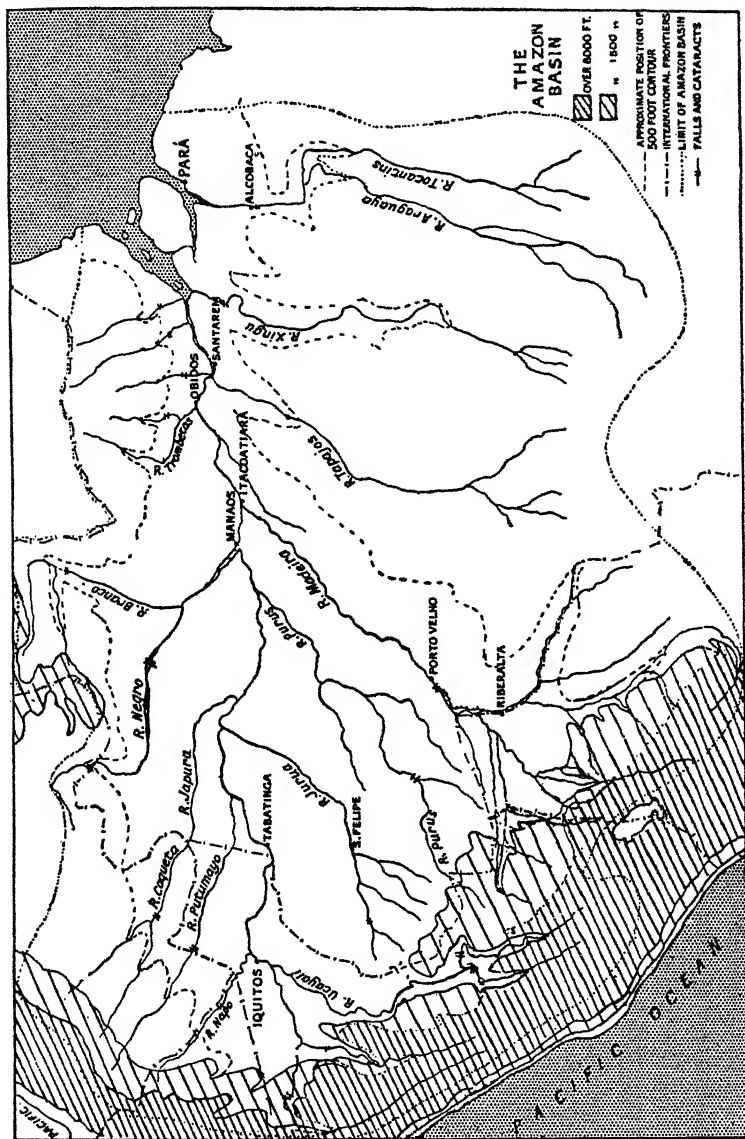


Fig. 13.—The Amazon Basin

Prior to the uplift of the Andes the drainage in what is now the Amazon region flowed westwards, and terraces that occur

on both banks of the lower courses of the Amazon and Xingú rivers are thought to represent the remnants of lacustrine deposits laid down at this stage. In the region traversed now by the middle Amazon or Solimões and the Japura, there are numerous backwater swamps and lagoons known locally as igapos, furos and paranás, that point to an incomplete infilling of the basin formed by the rise of the Andes to the west. Another extensive partially filled area occurs in the lowland area of Eastern Bolivia in the region now traversed by the rivers that unite to form the Madeira. This basin was formerly occupied by an immense sheet of fresh water, known to geologists as Lake Mojos, remains of which are still recognizable in the large lakes and swampy tracts between the Marmoré and the Beni (Fig. 37). In the delta region of the Amazon, on the other hand, recent submergence has taken place, and has not only increased the area of varzea underlaid by an ill-drained subsoil, but also allows the tides to be felt as far up as Obidos, 500 miles from the sea.

With regard to the nature of the soils in the lowlands of the Amazon basin, recent investigations go to show that the terra firme everywhere has the characteristics of well-drained land, though, as usual in regions that have carried forest, it is probably poor in organic matter. The alluvial soils, though potentially rich, suffer from periodical flooding and from permanent excess of water in the subsoil. The forest found growing on these lands is usually lighter both as to density of the vegetation and the height of the trees than that of the uplands. The very limited cultivation of crops carried on in Amazonia is confined mainly to the more elevated strips of alluvial material that lie between the rivers and their overflow channels, much like the levées on the lower Mississippi. In the upper and broader part of the basin the proportion of alluvial land to upland declines to much less than the average proportion, owing to the narrowness of the flood plains of all rivers except the Solimões and Ucayali.

Communication within the region of the Amazon basin is almost entirely by river. There is only one railway, the Madeira-Mamoré, built primarily to provide an outlet for the rubber collected in the basins of the Mamoré, the Beni and the Madre de Dios Rivers, but now carrying little traffic owing to high freights charged and to the decline of the rubber business. What is known as the Bragança railway, extending 200 miles eastward from the city of Pará, is not really within the basin of the Amazon, nor also is the short unfinished line that has been laid in the Tocantins valley, southwards from Alcobaça, with the intention of circumventing the first rapids.

The axial river is navigable for large vessels as far as Iquitos

some 2,000 miles upstream and for smaller craft up to the Manseriche Gorge where the Marañon breaks from the Eastern Andes into the plain.

The Madeira is much the greatest of the navigable tributaries; Porto Velho can be reached by vessels of 6,000 tons, but above that point there are over 200 miles of rapids on the main river and on the Mamoré before the long stretches of navigable water on the Bolivian rivers are encountered. Neither the Tapajós nor the Xingú can be navigated except for short distances, owing to the occurrence of rapids within about 100 and 200 miles respectively of their confluences with the main river. The Purús and the Jurua, however, are navigable for small craft to the borders of the Acre Territory, and the Ucayali and the Huallaga to the foot of the Peruvian Montaña. Navigation on the north bank tributaries does not extend very far for vessels of any size except on the Japura and on the Negro-Branco system. The underlying hard rocks crop out in the beds of the streams flowing south-eastwards from the Andes, along a line some 400 or 500 miles distant from the mountains. Thus there are rapids on the Napo and the Putumayo shortly above their intersection by the parallel of 2° S., and on the Japura slightly west of the 72nd meridian; but as the Japura flows through the swampy lowlands for a great distance below this point roughly parallel with the main river, the navigable stretch is correspondingly long. The Rio Negro is a navigable river as far as the Massurabi rapids at 66° W., and can be followed by launches as far as the Casiquiare channel which drains into it from the Orinoco. The Rio Branco can be ascended by river steamers up to about 2° N., just below the confluence of the Mucajahy, but other streams draining from the Guiana Highland region to the Amazon are all interrupted by rapids or falls within 100 miles of the main river. In connection with the navigation on the tributary streams of the Amazon, it has to be noted that the lower rapids on many of them are by no means a complete bar to the passage of craft. Canoes and launches can often use the rivers, especially when the water is high, for great distances above the limits of navigation for steamers; and where it is impossible even for small craft to negotiate the interruptions, there are frequently long stretches of smooth navigable water above them, the merchandise such as rubber on the upper tributaries of the Amazon and cattle on the higher sections of the river Branco being taken round the rapids or falls and re-embarked on larger vessels below.

The life and commerce of the Amazon lowlands is concentrated in a few ports along the main river. Of these Pará or Belém, which has excellent accommodation for shipping, is much the

most important, and is, in fact, one of the leading ports of Brazil. The second centre in the basin is Manaus on the Rio Negro, just above the junction with the Amazon. This port enjoys a favourable position, not only because it is the natural outlet for the Rio Negro basin, but also because it is situated about midway between the outfalls of the Madeira and of the Purus. It stands at the point where the maximum number of navigable highways in Amazonia more or less converge. As the difference between high water in the flood season and low water on the Rio Negro amounts on an average to at least 40 feet, a large floating dock has been constructed to provide facilities for the loading and unloading of vessels. Far up the Amazon is the Peruvian port of Iquitos which stands in a similar position to the rivers that drain the Montaña and the western lowlands as Manaus does in relation to the river system lower down. The remaining centres in the Amazon basin are either small ports built on high ground along the axial stream, such as Santarem, Obidos, Itacoatiará and Tabatinga; or are mere collecting and distributing settlements up the tributary rivers in the outlying parts, such as Porto Velho on the Madeira, Riberalta on the Mamoré, S. Felipe on the Juruá, S. Joaquim on the Rio Branco and Alcobaça on the Tocantins. The total population of the region is exceedingly small in proportion to the area. That of the whole Amazon basin, according to the figures of the census of 1950, is apparently less than $2\frac{1}{2}$ millions, of whom nearly a half live in those districts of the Pará State which are near the mouths of the great river system, one-fifth in Amazonas Territory, and another fifth in the Amazonian areas of Peru, Ecuador and Colombia.

With variations in the climate, soil and drainage throughout the lowlands and the Montaña, there are corresponding changes in the nature of the vegetation. On the north side of the basin, in the lee of the Guiana Highlands where the dry season is marked, there are extensive savannahs, and these are likewise found on the broad belts of uplands to the south, forming part of the Brazilian Plateau. Another grass-covered area occurs in the eastern part of Marajo Island. Within the great forested area one or another of the indigenous useful trees grows exclusively in certain districts, or is more abundant and attains greater size in some districts than in others. The *Hevea*, for example, though very widely distributed, flourishes in particular on the terra firme in the great arc 750 miles wide just east of the Andes, and traversed by the upper rivers from the Mamoré to the Juruá; the balata tree is found growing in the upper part of the Negro-Branco basin, but not elsewhere; the castilloa (*Castilla ulai*) is confined largely to the southern section of the basin, particularly

to the uplands between the tributaries, beginning roughly about 100 miles from the Amazon line ; the Brazil nut tree (*Bertholletia excelsa*) is common in the valleys of certain rivers such as the Tocantins, the Trombetas and the Negro-Branco belonging to the eastern and middle parts of the basin, but occurs less frequently elsewhere. With respect to timber-producing trees the forests of the swamp lands contain fewer species than those of terra firme, and yield a higher proportion of soft than of hard woods. The higher elevation on the Montaña, though it does not cause the forests to become thinner for several thousand feet up, naturally permits kinds of plants to appear towards the upper limits of the forest, that do not grow in the lowlands. Of these, two drug-yielding plants, namely the cinchona tree and the coca shrub are perhaps the best known.

The industries of the region are mainly extractive and connected with forest products. The gathering of wild rubber from different kinds of trees has for many years past occupied the leading place. Another important industry, and one that appears at present to be gaining ground, is that of collecting the nuts of the *Bertholletia excelsa*. Timber-cutting has not as yet come to occupy much attention, and the cultivation of crops is carried on in quite a small way, though cattle-rearing has developed to some extent in certain favourable parts.

Rubber is obtained in the Amazon region from at least three different trees, the balata, the castilloa and the hevea. The first of these is found in the uplands towards the frontiers of British Guiana, of Venezuela and Colombia. The trees usually grow scattered among others in the forests, but sometimes in clusters. Difficulties of communication and the relative scarcity of the trees prevent the collection of balata developing into a large industry, but such as it is, the industry appears to be prosperous. Its chief centre is Manaos, whence the product is exported and whither the gatherers go to spend their earnings. The second of the rubber-yielding trees mentioned above, the castilloa, is exploited in the basins of the great tributaries of the Amazon from the Araguaya to the Purus, especially on higher and better drained ground. The product of the tree is known in South America as caucho, and is considered somewhat inferior to that of the hevea. In order to extract the latex, the trees are generally cut down, a method that is proving to be very short-sighted, for the great handicap on the wild rubber industry of Amazonia has been, and still is, that of unsatisfactory communications. As the more accessible trees were destroyed, the collectors have had to go farther and farther into the wilds ; in many districts the remaining trees are now so remote as not

to be worth attention except when high prices are obtainable for raw rubber. In the lowlands of Bolivia and Peru where castilloas were formerly abundant, none now remain within reach of the ordinary means of communication, and though many are still no doubt in existence on the highlands in the southern part of the Amazon basin, they are likely to be spared for some time to come owing to their distance from the rivers.

The most important of all the rubber-producing plants is the *Hevea brasiliensis*, which in its Amazonian habitat is a tree which grows mixed with others along the banks of the main stream and its tributaries, both on lands subject to regular inundation and on the terra firme; although the tree does better on the latter, attaining a height of 130 feet there against 30 to 100 feet on the lowlands. Numerous varieties of *Hevea* are said to grow in the Amazon forests, some of which are useless. Of those that produce commercial rubber the best for quality of product are found in the Upper Amazon basin, so that the most important region is that traversed by the Purus, the Juruá, the Madeira and the Bolivian streams that unite to form the last-mentioned river. Since movement on land is almost impossible during the flood season, the work of collecting rubber from the *Hevea* can be carried on only for about six or seven months in each year, that is, during the dry season when the rivers are low. The seringueiros, as the rubber gatherers are called, have had to live a hard and unhealthy life, for as the industry has been customarily organized, they have hired themselves to masters who charged them exorbitant prices for all their requirements, and gave the lowest market price for the rubber brought back to Manaus, Itacoatiará, or Pará. The rubber-producing jungles of the Upper Amazon tributaries, especially of the Purus and the Juruá, have been notorious for fevers, and there has been a heavy mortality among the seringueiros who ventured for six months at a time into those pestilential river valleys. The usual method of obtaining the latex from the hevea has been by making incisions in the trunk, but this, though a less destructive procedure than cutting the trees down has, as practised, led to very much the same results. Such has been the pressure put upon the seringueiro to get as much rubber as possible during his limited working season and so little thought has anyone had for the preservation of resources for further production, that the more accessible trees have been drained of their sap so completely as to require years to recover productivity.¹ At the close of the

¹ "After a tree has been tapped for several years in succession, the yield diminishes and the tree is said to be cançado or tired. It is the custom to allow such trees periods of recuperation ranging from eight to twelve

nineteenth century South American rubber furnished the largest item in the world's supplies, but since the opening of the twentieth century the quantities so contributed have declined absolutely and still more relatively to the rest of the world. The position at various dates is shown in the following table.

PRODUCTION OF RUBBER IN 1,000 METRIC TONS

	South America.	Africa.	Asia.	South American percentage of total.
1913	45	18	51	39.5
1922	24	3	372	6.0
1939	16	16.1	984	1.6
1954	25.8	86	1716	1.5

The rapid advance of other producing areas has been due to the competitive advantage of plantation rubber grown where labour is abundant and relatively cheap. The African wild rubber industry has declined *pari passu* with the South American. The latter as conducted was doomed to eclipse as soon as the efficiently managed Asiatic plantations got into working order, simply because it was self-destructive. When prices fell after the War of 1914-18 to levels that proved unremunerative even to plantation producers, the South American industry sank to a low ebb. Whether it will recover in response to a rise in prices remains to be seen, for the most important question in this connection is whether in view of all the conditions, plantations are likely to be established on any large scale in the vast areas in Amazonia that are climatically so well suited to the production of rubber.

On the whole, it appears doubtful whether much progress will be made within measurable time. Any rapid increase in production must for the present come either from the opening up of new areas of untapped trees in the remoter regions of Southern Pará and Southern Amazonas and Northern Matto Grosso, or from the further destruction of castilloa trees. Recent authorities incline to the view that, given high prices, production can be raised to about 35,000 tons per annum, and possibly increased beyond that figure with improvements in transportation, but this is considerably less than the Amazonian output of over 45,000 tons in 1912.

Plantations at present are practically non-existent. Some small attempts have been made to establish them, though without much success, mainly, it appears, because the Brazilians have wrongly believed that the best situations for plantations are on years, after which they are tapped again."—"Rubber Growing in the Amazon Valley," U.S.A. Dept. Commerce, 1925.

the varzea or ill-drained alluvial land along the banks of the rivers. The outlook in this direction is not very hopeful, in spite of the fact that the Federal Government is making attempts to encourage planting. Labour is scanty and the difficulties have been made more serious by the exodus of rubber gatherers that has recently taken place with the decline of the industry. The high seasonal floods of the Amazon and of its great tributaries below the rapids prevent permanent settlement along their banks except on the stretches of rising ground close to the streams, but there the primeval forest attains its maximum density and demands the expenditure of much labour for clearing and keeping clean. Since also the rivers are the only means of communication there are obvious difficulties in the way of establishing plantations on the more open ground some distance away from them. Further, Asiatic plantations have now secured an enormous lead, and the establishment of competing plantations elsewhere would be a difficult enough matter in any case, involving a long period of waiting for an uncertain return on no small capital outlay; but the rubber districts of Amazonia not only have no capital for investment, but are suffering general stagnation owing to remoteness, since the decline of their main industry. Nor is it easy to see how outside capital will be tempted into the rubber-planting industry in those regions in spite of the interest shown in this matter by Americans as represented by their Department of Commerce. A modern rubber plantation requires considerable labour and a high level of skill and knowledge on the part of the management. Neither of these essentials is forthcoming in the tropical area of South America, and least of all in the enervating and unhealthy lowlands of the Amazon basin. Here, so far as rubber is concerned, Nature has been prodigal, but as if to spite man's efforts, she has placed peculiar physical and climatic obstacles in the way of the transition from a short-lived, purely extractive economy to a scientific mode of exploitation planned to yield ever-increasing returns.

As rubber-gathering has declined in the Amazon lowlands other industries have tended to take its place. Among these that of collecting the nuts commonly called Brazil nuts, is perhaps the leading one. The tree which produces these is known locally as the castanheiro and botanically as *Bertholletia excelsa*. It grows to a great size as its name indicates, and is, in fact, the tallest tree of the Amazonian forests. As mentioned above, it flourishes in the valleys of the great rivers that empty themselves into the lower Amazon and its estuary, so that the centre in which the trade is naturally concentrated is Pará. The fruit of this tree contains from fifteen to thirty nuts and weighs from 2 to

4 lb. When ripe it falls to the ground, and the business of collecting the nuts is therefore confined to working along the rivers in boats till the easily distinguishable trees are found, and then simply picking up the fruit from where it lies. Only the regions adjoining the rivers have so far been exploited. However, the nut-gatherers' work is not altogether free from danger, since in the harvest season the slightest breeze is apt to cause the mature fruit to fall from a height of perhaps a couple of hundred feet. Experienced gatherers are alert in taking cover by standing close up against the trunks of the trees when there are indications of danger. Since the nuts contain upwards of 73 per cent. of edible oil, their food value is very high and they are extensively consumed by the people of Northern Brazil. The castanha industry, as the Brazilians call it, obviously differs from the wild-rubber industry in that it does not involve any depletion of the forest resources upon which it depends.

Other forest industries in either Amazonia or the Montaña are of small importance. The gathering of cinchona or of Peruvian bark was at one time vigorously carried on in the eastern parts both of Peru and of Ecuador, but so ruthless was the destruction of trees that very few are now left in accessible places.

There is, however, a great wealth of timbers throughout these regions, which has as yet been scarcely touched. Some are hardwoods, heavier than water, and therefore difficult to transport alone, but others, such as balsa wood, are very light and rafts can be made of these on which to transport the heavier kinds down the rivers. The great obstacle to progress hitherto has been the fact that only a few kinds of timber, mostly cabinet woods and dyewoods, have been in active demand, and the costs of taking out single more or less isolated trees from the dense tangle of growth which prevails over wide areas has almost been prohibitive. Owing to difficulties of transportation, timber-cutting has been mainly confined to the swampy lowlands, where, although the forest is generally thinner, the greater part of the trees furnish soft woods, for which, just as on the coastal lowlands, there has been little demand in competition with supplies from the Northern Hemisphere. The abnormally heavy rainfall over a large part of the inner basin of the Amazon and the high seasonal floods are further obstacles to the development of a properly equipped timber-cutting industry. The lower-lying parts of the basin have been described as being as full of water as a wet sponge, and this is literally true at certain times of the year. In the search for new sources of timber less humid regions than these are likely to be exploited first.

The forests of the Amazon regions fall into three classes : the coastal forests, consisting largely of mangroves, and very similar to those on other equatorial shores ; the forests of the river flood plains, the composition and character of which change considerably with differences in the soil and drainage ; and those of the terra firme, rich in species, some of which supply timbers already established in the domestic market, and a few of which provide valuable woods for export. One of the best known of the latter is Spanish Cedar, which is sought by cutters even as far up as the Peruvian feeders of the Amazon system.

Some day almost certainly, when timber supplies are scarcer than they now are throughout the world, the vast forests of Amazonia will be utilized, but much capital will be required to develop them. In particular, there will be need for labour-saving machinery, and for the construction of means of transportation, and that under conditions which will give rise to peculiar problems in civil engineering. The mouth of the Amazon is nearer the English Channel than are the Gulf ports of the United States or those of West Africa ; and the Amazon itself is an excellent inland waterway. Once the problems of bringing timber cheaply to that highway have been solved, the very luxuriance of Nature and the riotous profusion born of the two great productive forces, heat and moisture, that now keep man at a distance, will be pressed into his service for the lavish supply of woods from trees selected and grown to suit special human needs, and incidentally also of food crops as well.

A certain amount of cultivation is followed in the Amazonian lowlands, mainly, however, in the neighbourhood of the towns and settlements, to supply purely local needs. During the rubber fever, in fact, so little attention was given to any other kind of production but the main one, that some of the food supplies had to be imported from outside sources. Since that industry has declined, more attention is being given to the cultivation of crops, especially in the State of Pará. Sugar-cane, cacao, mandioca, rice and tropical fruits, such as the banana, all do very well in many parts of the valley. As yet, however, very little more is produced from any of these plants except cacao than can be consumed locally. Though the cacao of the Amazon district is of a very high quality and in special demand for mixing purposes, the Indian growers are content to carry on their business in quite a small way. According to recent investigations also, cotton grows well in the drier part of the Amazon basin, and small quantities are being exported even from the remote region in the valley of the Ucayali in Peru.

Cattle-rearing is thoroughly established in two separate parts

of the Amazon region exclusive of the northern districts of the Brazilian Plateau. The first of these is the savannah country in the eastern half of Marajo Island where, however, considerable losses are experienced through the depredations of alligators that swarm in the marshy tracts into which the cattle are tempted during the dry season in search of fodder. The second is the upper part of the Rio Branco basin occupying a huge bay in the southern edge of the Guiana Highlands. In this region grasses constitute the prevailing vegetation except along the watercourses, and very large herds of cattle are reared for which a market is found in Manaus and other centres higher up the Amazon. Eastwards from the Rio Branco region, on the uplands between the valleys of the rivers that drain south to the Amazon, there are also further campos or pasture lands, but these do not appear to be much used for stock-rearing, either because of their dryness or because of the rapids on the rivers almost down to the main stream.

Our knowledge of the Amazonian lowlands and of the Montaña is very incomplete. Much of the country lying away from the rivers has never been explored; nor for that matter have all the rivers. Air surveys are useful in mapping waterways, but the difficulties of surface exploration are disproportionate to the prospective returns. To sum up briefly, however, it is clear that the whole region is one in which Nature still reigns more or less supreme; the population beyond the seaboard is exceedingly small, and though much human effort and life has been expended in attempts to exploit the resources, what has been accomplished amounts to but little. Enormous productive resources remain in reserve, to which serious attention will sooner or later be turned under the impulse of need in temperate countries, armed with the indispensable weapon, abundant capital.

NOTE.—Extensive deposits of high-grade manganese ore lying towards the Atlantic coast in Amapá Territory north of the Amazon delta, are now being worked. Production, which is already on a considerable scale, is expected to expand upon the completion in the near future of a railway to connect this ore field with a new port 125 miles distant, near Macapá on the Canal do Norte, the main outflow channel of the Amazon.

CHAPTER VII

THE ORINOCO LOWLANDS AND THE COLOMBIAN LLANURA

PHYSICALLY the basin of the Orinoco is an almost exact replica of that of the Amazon, but on a much smaller scale: the lower part of the plain through which the main river and its chief tributaries flow is generally level and liable to floods; towards the Andes in the west the surface rises first gently for a considerable distance, then abruptly; to the south there is an extensive plateau whose main watershed lies more or less parallel with the axial stream and well away from it, so that the Orinoco receives a large share of the drainage of that part of the plateau which lies west of its mouth, just as the Amazon receives a large share from a corresponding section of the Brazilian Plateau; the resemblance between the two basins is carried a step further by the manner in which the plateaus to the south of each continue to the east beyond the mouths of the rivers and throw a number of independent streams northwards to the Atlantic; both basins are bounded on the north by heights that present a fairly steep face towards the basins, and are drained by a number of relatively short and swift-flowing streams which act as feeders to the axial rivers; and finally, both the Orinoco and the Amazon regions communicate with the lowlands to the south of their upper parts by divides under 1,000 feet in height between the Andes and the eastern plateaus. Just as the Madeira-Amazon forms a great curve that hugs the Brazilian Plateau, so the upper and lower Orinoco form another curve that hugs the Guiana Plateau even more closely.

In one way, movement within the Orinoco Basin is easier than in the Amazonian lowlands, for forests are absent over much of the plains and the long dry season favours overland communication. The Spaniards penetrated easily in the sixteenth century as far south as the Guaviare and Caqueta Rivers, that is, to the northern edge of the great zone of tropical forests, although they founded no permanent settlements in these remote parts. In another way, however, movement in the Orinoco

Basin is more difficult than in that of the Amazon. The tributaries of the Orinoco are smaller in volume, are apt to spread themselves in wide, ill-defined channels, and diminish very much in depth in any case when the dry season sets in. The Orinoco itself is shallow and is interrupted by rapids at the lower part of its great bend, while the delta region affords no site suitable for an ocean port. In fact, even if accommodation for shipping were available, the general swampy nature of the ground and its unhealthiness are obstacles to the rise of a large centre there acting as an outlet for the basin.

Both the Orinoco and the Amazon were explored by Spaniards within the first half of the sixteenth century, but two circumstances favoured these ventures. Firstly, the comparatively open country in the upper part of the Orinoco Valley and in the extreme upper courses of the north-western tributaries of the Amazon rendered it fairly easy to reach the navigable highways of both rivers from the Spanish settlements in New Granada; secondly, the prevailing east, north-east, and south-east winds carried sailing ships up the rivers from the sea and the currents enabled them to move down stream. During the later sixteenth and the early seventeenth centuries, the Orinoco was frequented by adventurers of various nationalities in search of the legendary Indian prince El Dorado and his city of Manoa, supposed to exist in a region overflowing with gold somewhere in the mountain country beyond the headwaters of the western tributaries. It was not till the nineteenth century that Humboldt finally disposed of these fables, but from the eighteenth century down to the present time, the Orinoco Basin, being in reality almost devoid of precious minerals or any other form of easily won wealth, has been more or less neglected. The river highway is now frequented only by a few vessels that ply most actively when the river and its tributaries are high.

At the surface, the lowlands or llanos of the Orinoco and their continuation south-west into the basins of the Meta and Guaviare Rivers, consist almost everywhere of alluvial and Quaternary formations, but these are probably underlaid by Cretaceous and Tertiary rocks, such as appear on the flanks of the western and northern mountains. South of the Orinoco the much older rocks of the Guiana area rise from the floor of the plain at an average distance of some 50 miles from the river; between these and the river, however, beginning about 30 miles from its mouth, there is a line of iron-bearing ridges parallel with it, which represent outcrops of the ancient series that become continuous in the Guiana region. On the northern side of the basin, on the other hand, the mountain border has

broken down in two places, and the Quaternary deposits of the llanos run right through to the Caribbean in the Barcelona region, and to the Gulf of Paria farther east.

The soils of the llanos and of the llanura higher up are composed megascopically of materials ranging from silt to gravels, the latter occurring most towards the north and north-west, particularly on the series of mesas or low plateaus in the States of Guarico and Azoategui; the resulting ridge forms for some distance a divide between streams flowing south to the Orinoco and others flowing north to the Caribbean. Though the surface of the whole region appears to the eye monotonously level, there are few swampy areas except in the valleys of a number of smaller rivers north of the Meta, which broaden out here and there into marshy lakes. As a matter of fact, there is a general fall in the level from some 800 feet in the higher parts towards the low-lying tracts of the delta region. Where gravels rise to the surface the soil gets very dry between the rainy seasons, and the country is of the arid type; but in the upper part of the basin much moisture from the Andes percolates through the loose sedimentary material and irrigates the surface soil, even when the rivers in other parts run low or even dry up.

In climate the whole region is distinctly tropical. As noted in Chapter II, the rainfall is more or less confined to the summer season, beginning early in April and declining from July onwards. On the northern llanos there are generally two short rainy seasons followed by a long dry period during the so-called winter. The alternation of wet and dry periods combined with the high temperatures, averaging some 75° F. throughout the year, cause malaria and other fevers to be common in the stretches near the rivers. During the wet months floods are widespread and constitute a serious obstacle to communication otherwise than by the rivers, as well as to permanent settlements, except on bluffs along the waterways.

The prevailing vegetation in the eastern half of the basin consists of coarse grasses which become withered and sunburnt during the winter. In the great region traversed by the western tributaries of the Orinoco there are extensive areas of brushwood, while in the valley of the upper Orinoco and on the eastern slopes of the Andes true tropical forests appear. Tropical forests also occur in the delta region, but of the coastal type in which near the sea mangroves prevail. At least three-quarters of the lowlands in the whole basin, however, are either grass-covered or bare plains.

The rivers provide the chief means of communication, though numerous trails link the main river highway with the more

populous mountain and plateau regions both of Venezuela and Colombia. The Orinoco is hardly navigable by ocean-going vessels since it provides a depth of only 11 feet even at high water, owing to a partial obstruction in its course known as the Boca del Infierno at about 65° W. Navigation is of course completely interrupted by the Raudales¹ de Atures about 600 miles from the sea, above which are the Maipures rapids. The 47 miles of river between these rapids is generally navigable, and above the second of these interruptions there is a long stretch of navigable river in the upper course of the Orinoco. To make the whole river serviceable as a highway, a railway is necessary connecting the smooth water above the Maipures rapids with that below the Raudales de Atures, but owing to the remoteness and the small commercial importance of the upper Orinoco region, there is little likelihood of the line being constructed.

A few of the left bank tributaries of the Orinoco can be navigated by launches for longer or shorter distances according to the time of the year, in particular the Meta and the Apuré whose upper valleys communicate with passes over the Eastern Cordillera; but all these tributaries are apt to spread themselves in wide courses with numerous sandbanks and some, such as the Portuguesa in the state of the same name, disappear altogether in parts of their courses during the dry season. Those rivers that traverse the southern part of the great savannah and forest country in the Meta Territory of Colombia are of little service at present for intercourse, owing to the extreme scantiness of the civilized population. Parts of this region have not yet been explored.

The limited commerce of the whole lowland area draining into the Orinoco naturally concentrates in a few river ports and to a smaller extent in one or two inland townships either in the northern llanos at convenient points between the Orinoco line and the coastal region, or in the llanura at the foot of the passes into Colombia. Of the river ports the most important are Ciudad Bolívar (formerly Angostura) and San Fernando de Apuré. The former is situated well above the swamps of the lower Orinoco, and at a point that can be conveniently reached from the Caribbean by the Barcelona gap and where the Orinoco narrows down to half a mile in width. At the same time the only important mining region in the Guiana territory of Venezuela lies at no great distance south-east, and the Caroni Valley penetrating far

¹This term is applied by the Spanish to rapids in the form of a series of cascades, distinct from the salto or true waterfall. The total drop at Atures is from 30 to 32 feet. •

into the mountain country opens up almost due south. San Fernando de Apuré on the Apuré River is a centre upon which routes from the whole of the north-western llanos converge and which is also the nearest point on the river navigation from the passes over the mountains between the Cordillera de Merida and the Central Venezuelan Andes. About midway on one of the connecting routes is the inland centre of Calabozo, formerly a place of greater moment than it is at present. On the principal route from Bogotá to the Meta plains and the Orinoco is the small township of Villa Vicenzia which, when the savannah region of Colombia develops as a cattle-rearing area, is likely to become an important gateway centre. Since the llanos reach the sea at Barcelona and drain northwards for a considerable distance behind it, that town is also to be regarded as one of the points within the region upon which its traffic converges. Barcelona has the advantage not shared by any other place in the llanos, of being within easy direct reach by sea of the chief centres of population and trade in Venezuela.

Except for the outlet by way of Barcelona the lowlands of the Orinoco basin, in spite of their nearness to the coast, remain largely isolated. Communication between them and the populous coastal belt is hindered not only by the parallel ranges of the Venezuelan Andes, but also by the difficulties of travel over the roadless plains, rendered all the more troublesome by their climatic conditions. During the rainy season when there is fodder for beasts of burden, floods are common and the routes are apt to become impassable. When the dry season sets in, green vegetation becomes scanty and the daytime heat in the western llanos excessive owing to the prevailing east winds having blown over a heated land surface. A railway between Caracas and a point on the Orinoco would be of the utmost service in linking the inland plains not only with the important district round the capital, but also with the outside world.¹

The industries of the Orinoco lowlands are at present limited for all practical purposes to the rearing of horses and cattle. These animals, more especially cattle, have always been the chief products of the region. Towards the west the collection of forest products such as sarsaparilla and sarrapia has from time to time occupied attention, and in the Colombian llanura the gathering of rubber is a small industry. From the account given above of the llanos, it will be clear that they are far from ideal for cattle-rearing; fodder gets very scarce indeed in the winter and the mean temperature of upwards of 80° F. is excessive. The animals are poor in appearance and suffer dreadfully from plagues and pests. Moreover, at present there is no means of moving them

without heavy loss of condition from the plains to the coast. An attempt was made some years ago by an English Company to establish cattle-rearing on a large scale in the San Fernando de Apuré district to supply freezing works erected at Puerto Cabello, but the venture has met with very indifferent success.

It appears that there are now much fewer cattle in the Venezuelan plains of the Orinoco than there have been in the past. Diseases account for some of the decline, but the heritage of revolutionary outbreaks in the form of shortage of capital and an unwillingness to embark on efforts and outlays for which there is little immediate return, is also to be blamed. Advances in the industry require the expenditure of much capital and labour in improving the herds and pastures, eradicating diseases, and laying out proper means of communication. The Meta savannahs in Colombia are said to be naturally well suited to the cattle-rearing industry. Much of them lies at a moderate elevation, and the rainfall there is more evenly distributed throughout the year than in the llanos. But they are still quite cut off from the world's markets. Time alone will show whether they can become really important as a source of supply of cattle.

The population of the whole lowland arc from the Orinoco delta to the divide south of the Guaviare basin is very small. Economically it has lagged behind, while other parts of South America have shot ahead. The hardy cattlemen, known as Llaneros; who have adapted themselves on a primitive plane of existence to the trying conditions there, are the chief permanent inhabitants outside the few towns; and though efforts have been made by the central government as well as by foreign enterprises to develop the cattle industry on modern lines, little progress has been achieved.

¹ An ambitious programme of road construction has, in fact, been carried out in preference to extending the railway system. From the Great Andean highway linking Caracas with San Cristobal via Valencia and Mérida two others strike out into the Llanos: the Carretera Occidental over the western Llanos south-west from Valencia to San Cristobal where it joins the Great Andean, and the Carretera Oriental, running south-east (with several secondary branches) from a point near Caracas to El Tigre, where it joins the highway from Cumaná on the Caribbean to Ciudad Bolívar on the Orinoco (Fig. 15).

CHAPTER VIII

THE GUIANA MASSIF

THE Guiana Massif extends for over 1,000 miles east and west from the line of the upper Orinoco to within 100 miles of the Atlantic in French Guiana and in the northern angle of the Brazilian State of Pará. Its extreme width north and south is about 600 miles, this extension being reached in the western portion between the middle Orinoco and the Rio Negro and again in British Guiana. Towards the east the width of the block diminishes somewhat, though there the highlands advance farthest south and approach nearest to the course of the Amazon. The general slope of the whole mass is towards the north. The highest parts and the main watershed are followed by the line which marks the frontier of Brazil. There are extensive heights also above the general level towards the western border, but the rivers in that section have cut through these and now drain mostly towards the upper Orinoco. In so doing they descend by numerous rapids and it is not improbable that the upper basins of a number of them owe their present size to the capture of streams, now represented by lateral tributaries, that were once larger rivers flowing north towards the lower Orinoco or south towards the Amazon basin.

The highest point in the Guiana Highlands is in the Roraima group, over 8,000 feet above the sea and immediately overlooking the head valley of the Rio Branco. This river has evidently cut back into the plateau in the course of the ages, just as the Paraná has excavated a trough in the Brazilian Plateau. In its lower and middle courses the Rio Branco flows placidly through the lowlands. The first rapids occur at about 2° N. and indicate that there the river definitely becomes one of those draining the Guiana block. The rocks in the whole Rio Branco basin from the rapids northwards are of the crystalline type characteristic of the Guiana Highlands, and the name of the river itself owes its origin to the milky colour of its waters, a feature common to many rivers draining the micaceous rocks of that region. Just to the east of its upper course, the Rio Branco receives a tributary, the Tacutu, which flows almost due north for a considerable distance

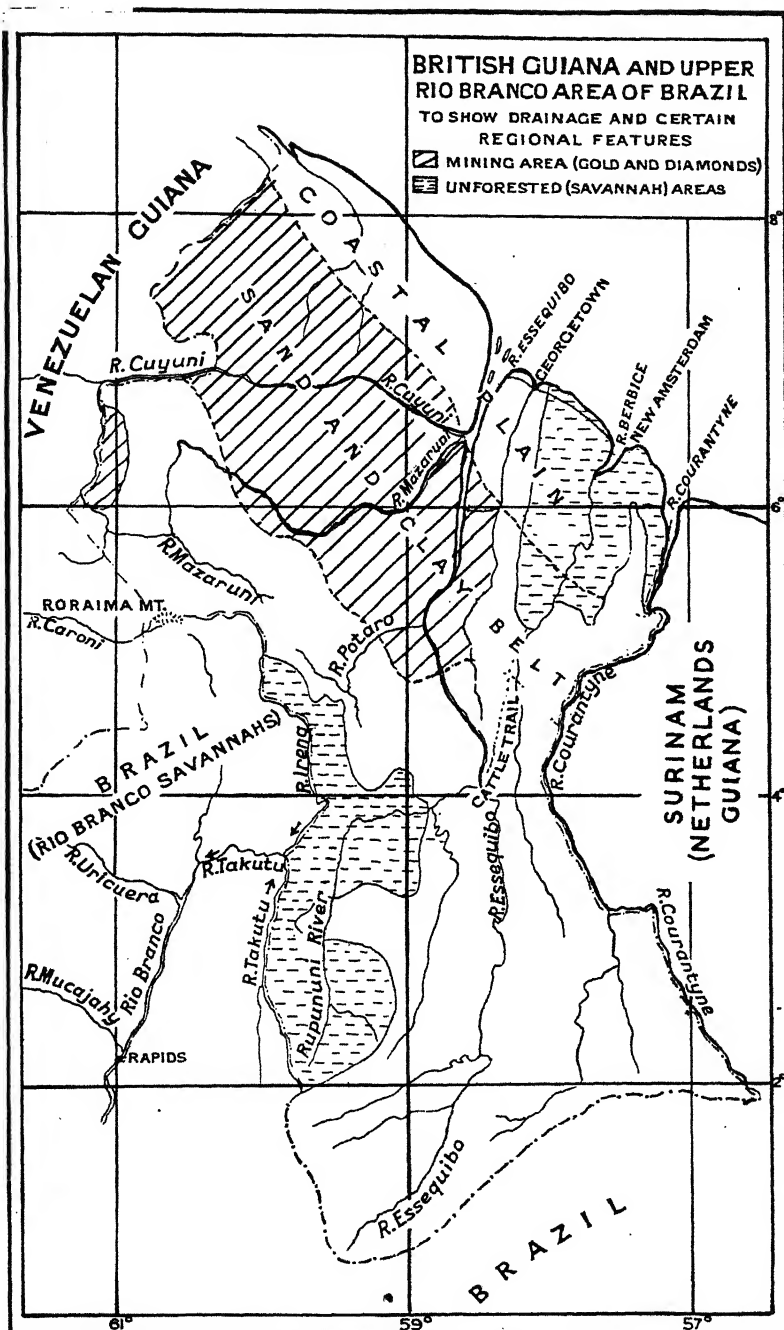


FIG. 13.—British Guiana

before turning west to enter the main river. Since a number of streams in the region east of the Tacutu flow in the same direction as it does, but continue northwards to the Atlantic, there is every indication that this river has been captured by the cutting back of a left-bank tributary of the Rio Branco. The relatively large area draining from the west into the last-mentioned river has provided it with exceptional erosive power along its upper and middle course, and has enabled it to assert itself against its weaker neighbours such as the headstreams of the Essequibo. In British Guiana almost the whole of the drainage of the Highlands is directly to the Atlantic, but farther east little more than half of the drainage is in that direction, the rest going either south to the Amazon or south-east by independent rivers. A clearly marked fall line cutting these southward rivers one after another a short distance above their confluences with the Amazon and its estuary marks the boundary between the southern edge of the Guiana Massif and the alluvial soils in the valley of the great river.

In geological structure the Guiana Highlands consist of a complex basal system of ancient crystalline rocks overlaid by thick horizontal strata of sandstone with thin beds of shale. The crystalline rocks consist mainly of granites, gneisses and related types of Archaean or Pre-Cambrian age. The sedimentary series have not yet been definitely assigned to their proper geological period; some authorities consider them to be Mesozoic, others would relate them to the Torridon formations in Scotland and to the Keeweenaw in Athabasca. Subsequently to the deposition of the sandstone formations—during the Triassic or a later period—the whole system of rocks in the Guiana region was intruded at numerous points by igneous material, mainly diabase.

In spite of their original thickness and their comparative hardness, the overlying sedimentary rocks have been removed by denudation except in isolated patches, where they stand up as flat-topped mountains. The Roraima heights represent one of these blocks. As seen from the south this mass presents a long and almost level line against the sky with a deep notch in the middle. The overlying sandstone weathers in steep cliffs which are peculiarly prominent on that face of the Roraima block that looks towards the Rio Branco plains. In the Rupununi district also, east and north-east of Roraima, sandstone formations are common and account in some measure for the prevalent savannah vegetation.

It appears that the northern edge of the Guiana region has risen slightly in recent times; at all events the rivers flowing north are actively engaged in cutting down their beds in the belt where they leave the uplands, and in so doing pass over a series

of low rapids. The coastlands of the region occupied by the European Colonies consist of mixed deposits of sand and clay, much of which has apparently been brought by currents from the mouth of the Amazon and deposited in what was formerly a shallow sea. In British Guiana this coastal plain varies from 10 to over 30 miles in width and averages about 20 miles, but in Surinam (Dutch Guiana) and French Guiana it is much narrower, while to the west the lowland tract between the highlands and the Orinoco is, as already observed, about 50 miles wide.

Since the greater part of the interior of the Guiana region is covered with dense tropical forests, exploration has been confined largely to the river valleys and to the tracts of savannah country towards the south. Almost the only inhabitants over wide areas are Indians, and detailed knowledge of the structure and relief of the inland parts is accordingly very scanty.

The climate, though tropical throughout, varies according to the situation and elevation. The coastlands are hot, but the high temperature is moderated by sea breezes from the north-east. There the alternation of wet and dry seasons is clearly marked, the former occurring twice a year in December-January and in May-July. In the dense forest belt beyond the first falls on the rivers the distinction between the seasons is apt to become effaced and the damp heat is often oppressive. On the savannahs of the far interior the temperature is diminished by elevation, the rainfall is less than elsewhere in the region,¹ a well-marked dry season occurs from October to February; and the climate is on the whole agreeable, sometimes even unexpectedly cold. The above account refers in particular to the conditions in that cross-section of the Highlands represented by British Guiana, but recent explorations show that substantially the same climatic sequence occurs in the eastern half of Venezuelan Guiana, and since the western half is sufficiently elevated to receive abundant seasonal rains, and forests and savannas clothe the whole area, it appears that similar climatic conditions obtain there as in the densely forested belt of the British colony. In Dutch and French Guiana, the smaller average distance from the sea, the absence of intervening heights, and exposure to the south-east as well as the north-east trade winds, render the climate more humid and oppressive and cause tropical forests to reign supreme over 95 per cent and more of the area.

Intercourse and movement within the Guiana region are unusually difficult. Except for short lines in British Guiana there are no railways, and roads are to be found only in the settled

¹ A nine years' average rainfall on the Rupununi River has been given at 58.51 inches.

districts, apart from the forest motor roads in British Guiana (see p. 109). Rough trails exist here and there running from the coastal or Orinoco river ports into the interior, but otherwise inland communication is confined to the rivers. Every one of these, however, plunges over rapids within a short distance of its mouth, and though some of the larger, such as the Essequibo, can be used by canoes above the first rapids, almost all have further cataracts higher up. Altogether the plateau rivers are not of very much use in providing means of transportation. This, however, does not apply to the Orinoco, which by skirting the western and north-western edges of the massif, makes it possible to reach districts that otherwise would remain completely cut off from the outside world.

The Brazilian frontier being where it is, the central and interior parts of the Guiana Highlands are oriented politically and economically towards the north and north-west, but so little progress has been made towards the development even of the northern and easily accessible lowland margin of the region that little thought has been given to the construction of highways for the exploitation of the resources of the interior. It is true that the obstacles to be faced are very great. The climate becomes more trying for Europeans in the first part of the forest belt above the lowland strip, while the rank forests themselves are a serious hindrance. Labour is very scarce, since the Indians remain wild and refuse to be mobilized for work. Moreover, the heavy seasonal rains would tend to impair here, as they do in Eastern Brazil, such man-made works as roads and railways. It will apparently be a long time, unless rich gold deposits are discovered in the interior, before forest trails and simple river canoes are superseded throughout those parts of the Guiana area, amounting to a good two-thirds of the whole, that drain to the Orinoco and to the Atlantic.

On the southern slope, in Brazilian territory, communication is in some directions easier. The region is less exposed to the north-east trades; the rainfall is therefore lighter, and the forest cover less continuous. Further, the Negro-Branco river system provides a navigable highway that penetrates, as already seen, well towards the heart of the Guiana Plateau. The upper Negro serves as an avenue of approach to the south-western parts, just as the upper Orinoco does in respect of the north-western parts; and it finally communicates with the Orinoco itself by means of the Casiquiare Canal, navigable for launches.

This natural passage, 227 miles in length, has been caused by overflows from the Orinoco in times of flood when the river rises 15 to 20 feet. The Orinoco has thus been able to breach its banks

and to form first a lateral lake, and subsequently a well-defined side channel. There is a fall of 69 feet from the Orinoco mouth of the Casiquiare Canal to its outfall into the Rio Negro ; thus the current is relatively slow. The bed of the channel is now down to the hard crystalline rocks common in the Guiana Massif and general also throughout the course of the upper Orinoco. Hence little erosion is taking place at the present time and the peculiar



FIG. 15.—Venezuela : Modern Developments

bifurcation of the great Venezuelan river may therefore be regarded as a permanent feature in the drainage of the Southern Guiana Highlands. Scarcely any traffic, however, passes through the channel, partly because of the international boundary just below the southern end, more because of the extremely undeveloped state of the wild regions in the upper basins of both the Rio Negro and the Orinoco, which have hitherto been exploited only for rubber.

Whatever centres of population and commercial movement serve the Guiana region, are all situated on the coastal strip or on bluffs clear of floods on the banks of the Orinoco. Ciudad Bolívar in Venezuela, already mentioned, is one of these and San Fernando de Atapo, higher up where the large affluent, the Ventuari, joins the main river, is another. In British Guiana, Georgetown is relatively quite an important centre. The port has the advantage of being in touch with the valleys of two considerable rivers, the Essequibo and the Demerara, both of which are navigable by fair-sized vessels for some 60 miles inland. In the neighbourhood of this town also the coastal plain is wider and contains more open unforested land than anywhere else in the Guianas. The savannah country continues eastwards as far as the lower course of the Berbice River, at the mouth of which is the only other important centre in British Guiana, namely, New Amsterdam. Farther east in Surinam and French Guiana, where the belt of coastal savannahs becomes narrower, the trade of each of these colonies is centred in one small port; Paramaribo at the mouth of the Surinam River depends for its existence mainly on the export of sugar and of forest products from the interior, while Cayenne has little to recommend it beyond the fact that it is the capital and the only place where white men are to be found living voluntarily in a territory that remains almost entirely undeveloped.

The industries of the Guiana Highlands proper comprise the collection of special forest products, a limited amount of timber cutting, mining for various minerals, and in one district stock-rearing. The agricultural industries of the coastal lowlands, of importance only in British Guiana, have been dealt with in general in Chapter V above.

Of the forest products balata occupies the first place. The trees grow scattered among others in the forests, but occasionally in clumps, all the way from French Guiana to the upper Orinoco line in Venezuela. They are more abundant in the hilly district than in the swampy lowlands. Surinam has hitherto been the largest producer of balata after Venezuela, but recent reports indicate that the supplies from that area are likely to decline in consequence of primitive and wasteful methods of exploitation. In British Guiana precautions have been taken by the Government to preserve the trees from destruction: the gum cannot be gathered except by licence; no tree can be cut down without written authority; the trees may not be tapped until they have attained a certain size, nor re-bled before the previous incisions have healed. In this colony the chief centres of the industry are in the Berbice and in the Rupunani districts. In Venezuela

balata is obtained mainly from the southern district known as the Amazonas Territory, where also certain smaller quantities of rubber are collected. The exports of balata are shipped at Ciudad Bolívar, but some of the rubber finds its way to Manaos. Two other forest products of some importance in Venezuelan Guiana are the tonka bean or sarrapia, a fruit which is also exported through Ciudad Bolívar, and is used in the manufacture of snuff and perfumery, and *Bertholletia* nuts from the extreme southern area.

The forests of the Guiana Highlands yield a variety of timbers, most of which are hardwoods. In fact, owing to the prevalence of two characteristic kinds of trees producing timber of this type, the forests in this region are known as the greenheart-mora group among those of South America. Numerous other useful trees, however, are found in different parts of the forested tracts of the highlands, since the composition of the forests varies considerably according to local conditions. Among these are crabwood, which grows abundantly on the lowlands of British Guiana, purpleheart and wallaba, common in the central parts of both British and Dutch Guiana, Spanish cedar and balsa, occurring in the region towards the upper Orinoco in Venezuela. Beside these there are scores of timber-producing trees in the several-storied forests that cover upwards of nine-tenths of the Guiana region north of the main watershed. Recent investigations made in French Guiana on behalf of the French Government, for example, indicate that the forests there contain trees yielding 112 different kinds of wood of economic value, of which light and fairly light woods comprise 21 per cent of the total stand and heavy durable woods about 31 per cent.

Hitherto, almost the only timbers that have been commercially exploited in the Guiana region are those of this last-mentioned class, including mora, crabwood and greenheart. Limited quantities of these are exported from British and from Dutch Guiana for dock and naval construction work in Europe and North America. Transportation is at present much too difficult for any large-scale timber-cutting industry to become established, and the great wealth in cabinet woods accordingly remains almost untouched. On the whole, however, the Guiana forests constitute one of the world's more important untapped timber reserves. Thanks to their nearness to the sea or to the Orinoco highway, the task of exploitation will be easier when the time comes, than in many forested regions in continental interiors elsewhere. All that is really wanted to make them readily accessible is the construction of a number of short railways into the uplands from the coastal or river ports.

Mining for gold has long attracted attention in the northern parts of the Guiana Highlands in a belt that runs parallel with the coast behind the recent alluvial formations, from the region above the Orinoco delta in Venezuela south-eastwards into French Guiana. The belt attains its maximum width of about 100 miles in British Guiana. It presents the same characteristics throughout, namely a surface covering of weathered rocks composed of clay and sand underlaid by a basal system of crystalline rocks with numerous igneous intrusions. Gold is obtained mainly from diggings in the river gravels, lodes being difficult to find and to work owing to the thick cover of weathered material overgrown with forest. The Caretal district in the upper valley of the Cuyuni River, 150 miles south-east of Ciudad Bolívar, is probably the most important producer in the Guianas. At one time the El Callao mine was the greatest gold mine in the world, but at the present time the chief centre in the district is a place called Guasipati. The alluvial gold-mining area continues beyond the frontier in the valleys of a number of rivers in British Guiana, and also still farther east in Dutch and French Guiana. Diamonds as well as gold are obtained from the water-borne gravels in the middle valleys of the Cuyuni, Mazaruni, Potaro and other rivers of the western part of British Guiana. According to recent returns, the gold produced in that colony has declined to a very small yearly value, while that of diamonds, formerly amounting to a million pounds annually in value exclusive of those that escape registration, has likewise declined. A third mineral, namely high-grade bauxite, is now being worked in British and in Dutch Guiana, where it occurs in the residual deposits on the southern margin of the coastal sediments and as a result of alteration of clays and laterite earths. These deposits are easily accessible by means of the navigable lower courses of the rivers, an average of 5.6 million tons of the ores being exported in 1953-54, mainly to North America.

An industry in the Guiana region that promises to expand in the future, but which at present is conducted only in a small way, is cattle-rearing. On the savannahs of the interior of British Guiana towards the Brazilian frontier the vegetation consists of grasses, dwarf shrubs and herb-like plants which already provide nourishment for considerable herds of cattle, the surplus animals being driven to the coast by the Rupununi trail as it is called, extending from a point 100 miles up the Berbice River for a distance of 240 miles. These Rupununi savannahs are an extension of those of the Rio Branco immediately to the west in Brazil, and are continued eastwards with occasional forest interruptions through Northern Brazil to within 100 miles of the Atlantic.

This whole line of savannahs mainly on the southern slope of the Guiana Massif extends through a distance of 1,200 miles from the upper Orinoco, and at some perhaps not far distant time this region may be developed to become an important cattle-ranching area. For the present, however, these interior savannahs, separated from both the Atlantic coast and the Amazon waterway by broad belts of equatorial forest, are largely isolated. Except at their western end, where they are accessible by the long trail from Georgetown and by the Rio Branco route from Manaus, they remain neglected, occupied only by scattered groups of primitive native Indians.

NOTE ON THE CERRO BOLÍVAR IRON ORE DEPOSITS

The older El Callao goldfield of Venezuelan Guiana is now rivalled in activity by the newly developed Cerro Bolívar iron ore field, situated about 50 miles south-east of Ciudad Bolívar, and about 40 miles south of S. Felix at the confluence of the Caroni with the Orinoco. The ores are high-grade, containing over 60 per cent of metal. They are transported by railway to S. Felix or to Puerto Ordaz opposite S. Felix across the Caroni, where they are loaded for shipment to the United States. Production rose from $5\frac{1}{2}$ million tons in 1954 to over 11 million tons in 1956.

CHAPTER IX

THE BRAZILIAN PLATEAU AND THE GREAT INTERIOR

THE Brazilian Plateau is one of the great upland masses of the world, occupying as it does an area of close on a million square miles. If the outliers of the plateau to the north and the west, covered by recent fluvial deposits and exposed in the cataracts of the rivers, are included, the total area is considerably more. The elevated region is roughly the shape of a right-angled triangle, the hypotenuse being represented by the eastern edge, and the shorter of the two remaining sides by the northern boundary towards the lower Amazon. With the exception of a relatively narrow strip in the north-east, the area as a whole falls towards the interior of the continent but preserves a ridge of highland running from a point near the middle of the hypotenuse side in the east to another about the middle of the longer remaining sides in the west. This ridge is in reality one of the most striking features in the relief of the plateau, for from it drain all the main rivers either northwards or southwards.

The Brazilian Plateau is also one of the oldest land masses in the world. It is doubtful whether the higher eastern parts have been submerged since the earliest geological period. If they have, any sedimentary deposits laid down have since been removed. During the Cretaceous period the continent as a whole was lowered and the northern and western parts of the Brazilian Plateau shared in the movement. Re-elevation took place, however, in early Tertiary times on a large scale, and since then the plateau as now known has constantly remained dry land.

The rivers of the plateau have accordingly had a long time in which to excavate their valleys both before and after the partial submergence. In doing so, none of them, not even those of the extreme south, has been interrupted by glaciation such as has occurred extensively in regions more remote from the Equator in South America and in other parts of the world. The river valleys are thus well developed; they are as a rule deeply cut into the hard rocks of the plateau and are comparatively broad;

the river beds are so graded that the water descends from the plateau rather by a series of cataracts than by great waterfalls ; tributaries tend to enter the main streams by valleys whose lower parts are worn down to the same levels as those of the receiving streams ; and the whole inland drainage is concentrated in a small number of powerful rivers.

The eastern scarplands of the plateau are the only part in which well-marked mountain ranges have been developed. Two factors have contributed to the formation of mountains here more than elsewhere on the plateau : firstly, the high eastern edge contains a belt of ancient, much-folded and very resistant rocks ; secondly, rivers have been actively at work denuding the surface both on the steep Atlantic slope and on the gentler one inland, but have left a neutral zone, as it were, of minimum denudation along the watershed. Changes of temperature, frost, and glaciers which play such havoc with elevated ridges even of hard granite in other parts of the world have never come appreciably into action in Eastern Brazil, where, moreover, the coastal and more exposed face of the great ridge has for ages been clothed almost to the top with luxuriant forests which have provided additional protection from the elements.

The eastern rim of the plateau is distinctly traceable in the line of heights that extend never far from the coast all the way from Cape S. Roque to Rio Grande do Sul. From the latitude of Rio de Janeiro northwards a number of the coastal rivers have succeeded in cutting back their heads well beyond the original eastern edge of the plateau in spite of the obstacles to erosive activity. Thus the main heights now lie along a line beginning near the Tropic of Capricorn with the Serra de Espinhaço in Minas Geraes and continuing northwards in the same direction about 100 miles east of the right bank of the São Francisco (Fig. 18). The deep and broad valley of this river leaves another series of heights inland aligned along its left bank at roughly the same distance. The course now followed by the São Francisco from the beginning of the great bend onwards is peculiar, and suggests the capture of the main river at some fairly remote time by one working back from the coastal region. Two features point in this direction : a depression, the lower part of which is now followed by the Assú River, can be traced beyond the bend of the São Francisco, running north-east in the same direction as the main course of this river ; and the cataract, by which the São Francisco leaves the plateau, retains the steep plunge characteristic of the descent of a less mature river than the São Francisco otherwise has the appearance of being.

In the region behind Rio de Janeiro the Paraíba do Sul

River occupies a longitudinal trench resembling that of the São Francisco, but on a smaller scale as to the length and the breadth of the valley and as to its distance from the sea. Here also, then, there is a twofold system of mountains left standing high above the surrounding levels. In the outer series the Serra do Mar is the chief ridge, while across the Paraíba Valley the inner series is marked by the Serra da Mantiqueira which forms

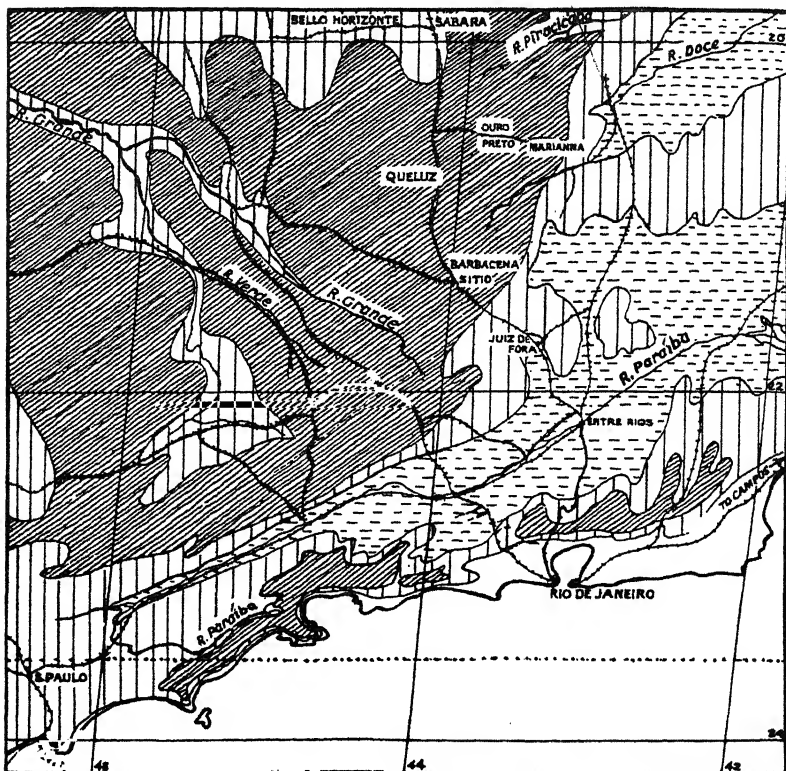


FIG. 16.—The Hinterland of Rio de Janeiro

Area over 900 metres in diagonal shading, 600 to 900 metres in vertical ruling, 200 to 600 metres broken ruling, under 200 metres left blank.

an integral part of the plateau and continues northwards into the Serra do Espinhaço which lies, as already noted, east of the São Francisco. The Paraíba Valley is a more or less level-floored down-faulted trough aligned with the old ranges in this part of the coastal zone, while the similar valley of the São Francisco is another longer and broader trough aligned in its turn with the coastal formations; the Rio Doce and other rivers northwards

to the lower São Francisco are consequent streams developed upon the uplifted zone of the Serra de Espinhaço, and their courses are interrupted by rapids from their sources to near their mouths.

For over a thousand miles south of Rio de Janeiro the steep eastern edge of the plateau hugs the coastline and forms the main watershed. The drainage is therefore entirely towards the Paraná and the Uruguay. In descending towards the low-lying valley of the former river, the streams have developed numerous waterfalls and cataracts, beginning often not far from their sources, thus providing waterpower conveniently available to the centres of population towards the eastern part of the plateau. The Iguassú River, however, on approaching the Paraná, and the Paraná itself nearly 150 miles higher up, cross ledges of basalt rock which cause them to form great falls at these points. Those of the Iguassú are among the largest and grandest in the world.

Beyond the line formed by the upper Uruguay and the westward course of the Paraná the Brazilian Plateau begins to break down. The coastal region is invaded by the sea in the Lagoa dos Patos and the Lagoa Mirim, and the uplands degenerate into a low flat ridge which steadily diminishes in height from Southern Brazil across the Uruguayan frontier, until towards the La Plata Estuary it gets completely lost beneath recent river and wind-borne materials, except at a few isolated points.

Throughout the whole of the plateau that lies to the west of the eastern heights described above, denudation has worked unevenly, so as to leave broad, flat-topped areas, called chapadões by the Brazilians, between the river valleys. These are especially marked in the northern and north-eastern regions, where thick deposits of sandstone cover the crystalline rocks. The chapadões consist largely of open savannah country which can be readily utilized for stock-rearing in those parts that are at all conveniently situated to populous districts or to lines of communication. Towards the lower Amazon, flat-topped heights face similar formations on the north side of the river. The trough now occupied by the Amazon from the Madeira confluence to the sea is known as the Devonian syncline. On both sides of the depression there is the same basal complex of Pre-Cambrian rocks overlaid by Devonian strata. In the northern parts of the Brazilian Plateau, however, the latter are capped with sheets of Carboniferous and Permian limestones, which extend eastwards as far as Piauí, but which are missing on the Guiana side of the lower Amazon. The geological structure in this area is shown in the cross-section diagram, Fig. 17.

The uplands of Mato Grosso and of Goiás in the western

interior of the plateau are covered extensively with nearly horizontal Mesozoic sediments. Their surface is therefore remarkably flat as a whole, the only variation in the relief being the valleys of the streams which tend everywhere to be wide and marked by lines of bluffs towards the top on either side. Towards the Andes these plains are continuous with the llanos of Eastern Bolivia, which, though intersected by the valleys of rivers flowing north-west into the Madeira, link directly with the eastern foothills of the Andes. The main transverse watershed of the continent, after running north-west across the Brazilian Plateau as far as the western parts of Matto Grosso, then turns sharply to the south-west and finally meets the Andes in the neighbourhood of 20° S. Within the angle so formed lies the upper basin of the Paraguay River, the central parts of which are low-lying,

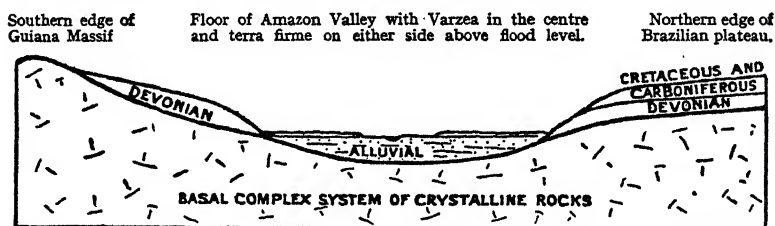


FIG. 17.—The Devonian Syncline on the Lower Amazon
Diagrammatic section across the Amazon Valley along about the 55th meridian showing arrangement of structural formations (vertical scale much exaggerated).

flat, and swampy, particularly on the Brazilian side. The eastern borders of these marshes represent in reality the boundary line between the uplands of the Brazilian Plateau continuous eastwards to the Atlantic, and the Chaco lowlands marked by seasonal or permanent swamps and sweeping unbroken to the region of the lower Paraná.

Exposed formations are much more extensive in the Brazilian Plateau than in the highlands north of the Amazon, and for this and for other reasons more is known about their geological structure, in spite of the fact that over much of the whole area few field surveys have yet been made. Within the borders of the great region where the results of geological forces at work over an immensely long period of time are now observable in the surface formations, it is natural that there should be a great range of local variations in rock composition. Igneous intrusion, regional metamorphism and intense compression have all contributed to differentiation in the character of the rocks. Thus the basal Pre-Cambrian sedimentary and crystalline series that compose the mountains and uplands in East-Central Brazil contain

granites, gneiss, schists, phyllites, quartzites, porphyries among other types. With these rocks and their derived gravels and sand almost all the minerals of Brazil are associated.

Towards the northern and south-western edges, and especially in the western tracts of the plateau, the basal complex is covered, as noted above, with sedimentary strata of Palæozoic to Mesozoic age. Carboniferous limestones abound in the northern sector, but are not associated with coal measures, which in Brazil are limited so far as hitherto discovered to Permian rocks in the south. In striking contrast with the Cordilleran zone of South America, Brazil north of the Tropic has been free of volcanic activity since Pre-Cambrian times; though a very large area in southern Brazil (Fig. 26) has been covered with diabasic basalt lava sheets of early Jurassic age.

The climate of the Brazilian Plateau varies considerably according to latitude, elevation, the direction of the prevailing winds, and to the amount and distribution of the rainfall. Generally speaking, however, it is sub-tropical, except in the deep valleys of the Amazonian tributaries which represent simply extensions of the equatorial climatic region of the Amazon Valley, and in the North-East where the annual average temperature of about 80° F. on the uplands makes the climate of that section rather of the tropical than of the sub-tropical type. The continental situation of the western interior causes it to have a high temperature during the summer when the winds blow from the equatorial region, but to be subject to very variable temperatures at other seasons with changes of the wind between northerly and southerly points. On the plains of Mato Grosso, for example, violent fluctuations of as much as 50° F. in the space of forty-eight hours are not unknown. In the southern limb of the plateau below the Tropic of Capricorn the climate is still sub-tropical even on the uplands of the State of Paraná, but gradually passes to temperate on those of Rio Grande do Sul.

The rainfall is markedly seasonal everywhere except in the two southernmost states, and on heights with an easterly exposure farther north. This feature sets distinct limits upon the range of forests on the plateau. Evergreen tropical forests naturally flourish in the hot, moist valleys of the Tapajós, Xingú, Tocantins and other northern rivers and on the lower slopes of the plateau towards the Amazon. They also cover extensive areas drained by the headstreams of the Paraguay in Mato Grosso, where they represent a southern extension of the selvas of the upper Madeira. Elsewhere, however, evergreen forests are restricted either to rain-exposed heights such as those between the São Francisco and the Tocantins-Araguaya system or to lines of

seepage at the foot of bluffs and along the sides of the ridges. Another and somewhat peculiar type of tropical forest is found in scattered areas on the plateau, north of 15° S. This is the open and usually deciduous forest characteristic of dry tropical and sub-tropical regions in South America. Its composition varies greatly according to the moisture available and the character of the soil. In the most favourable situations useful trees such as special hardwood and dyewood species, together with manihot and maniçoba, and carnaúba palms are found, but the vegetation often degenerates into mere scrub in which thorn bushes and cacti predominate. This drought-resisting kind of tropical forest covers large areas in the São Francisco Basin and in the country to the east of it as far as the borders of the evergreen coastal forest zone; also further areas in the southern parts of Maranhão and Piauí and in the central part of Goyaz. A third type of forest zone; also further areas in the southern parts of Maranhão and Piauí and in the central part of Goiás. A third type of draining towards the Paraná in the states of São Paulo, Paraná and Santa Catharina.

Practically two-thirds of the Brazilian Plateau, however, is climatically unsuited to forest vegetation and is covered now as it was originally with grasses, herbaceous plants, scattered bushes and occasional groups or ribbons of palms. According to estimates made officially in Brazil the percentages of the total area originally forested in certain of the states are as follows: Piauí 23, Ceará 43, Rio Grande do Norte 25, Goiás 28, Mato Grosso 39, Minas Gerais 46, São Paulo 81. These states together account for upwards of three-quarters of the area of the whole plateau in their upland sections. When the necessary deductions have been made from the above figures for the heavily forested lowland parts of the states not belonging to the plateau, the average of the net results may be taken as fairly representative of the proportion of originally forested land in the Brazilian Plateau.

The means of communication and the industries in the whole eastern section of the plateau will be discussed in detail in the succeeding chapters. So far as these economic features are concerned, it is convenient to limit the account here to the western parts occupied by the states of Goiás and Mato Grosso, which together include within their borders about one-third of the area of the plateau.

The most striking feature in the situation of these interior tablelands is their remoteness. The town of Goiás is about 600 miles from Rio de Janeiro, and Cuiabá, the capital of Mato Grosso, more than twice as far. The western borders of the plateau in the same state are more than 1,500 miles from the east

coast. Two railways have been constructed into the southern part of this immense region, one, the Goiás Railway from Northern São Paulo via Uberaba and Araguay to a point some distance beyond the Goiás boundary, the other from Bauru in São Paulo through to Porto Esperança on the Paraguay. Neither of these, however, is of any great value for the carriage of bulky produce outwards, since the freights are necessarily high and there are changes of gauge between the interior and the coast. Neither the construction of further main railways into these interior plateau states nor the extension of the Goiás line could be expected to help the situation, because the traffic would be too small to enable the railways to provide a cheap and reliable service. Cattle, which constitute the most important item of produce, still tend to be moved from the interior to the São Paulo border in the old way, namely by driving the animals in easy stages.

River outlets from the region, except that by the Paraguay mentioned in Chapter IV above, are of still less service than the railways. The São Francisco, though it breaks through the coastal ranges, is of little value as an eastern gateway, partly because of the interruption caused by the Paulo Afonso Falls, partly because its upper navigable course is separated from the plateaus of the western interior by ranges of high mountains on the frontiers of Goiás. The Paraná in its upper course passes through a densely forested region liable to floods, is therefore difficult of access, and is moreover interrupted by cataracts and rapids. The northern rivers have been explored by the seringueiros in search of rubber only as far up their courses as the first rapids. Beyond these there lies a zone in which the rivers plunge over numerous other rapids and which remains a *terra incognita* to the inhabitants both of Amazonia and of the savannahs on the plateau. The Madeira alone of the northern rivers has a long stretch of navigable water continuous with that on the Amazon, but the main stream of the Madeira does not really belong to the plateau at all, and is separated from the open uplands by several hundred miles of dense equatorial forest, while its right-bank tributaries from the plateau are all broken by rapids.

Much of this interior region was overrun about 1560 by raiding parties known as the Entradas in search of Indian slaves, and these were followed later by the Bandeiras from São Paulo (cf. p. 40); but the remoteness of the region has doomed it to very slow progress in peaceful colonization. The population is still very small, and the exploitation of the resources of a most primitive and extensive type as indicated by the average size of the fazendas or holdings, amounting to over 5,000 acres. There is very little agriculture, the principal crops being mandioca, maize

and rice. Nor is the main industry in an altogether flourishing condition ; the cattle are of a poor quality and suffer severely from a pest known as the tick, which by boring into the skins of the unfortunate animals is apt to spoil the hides. The meat is not of a kind fit for a high-class frozen or chilled beef trade, even if the animals could be transported at reasonable cost and without loss of condition to the eastern ports. Yet there are upwards of 6 million cattle in Mato Grosso and Goiás ; the surplus animals from which are taken either to Eastern Brazil to be fattened for fresh beef or are sent to the saladeros or salt-beef factories in Brazilian territory or farther south on the lower Paraná and Uruguay Rivers.

Mineral deposits of some importance exist in Southern Mato Grosso, which is second to Minas Gerais among Brazilian states in the production of gold, and possesses a diamond field in the region round Cuiabá. These two minerals are actively worked, since transportation costs are a relatively small item. Manganese ores have been mined in the Urucum Range near Corumbá in the same state, where deposits exist estimated to contain 30 million tons of high-grade mineral, the largest in the world. Ores from this source have been exported down the Paraguay River through Rosario. The handicap of great distances to ports, either 1,200 miles by rail to Santos, or 2,000 miles by river to Rosario, has hindered exploitation of these deposits in competition with the more accessible sources in Amapá Territory (p. 93) and Minas Gerais (p. 128).

The name Mato Grosso, meaning large forest, is in some degree a misnomer, since much less than a third of the plateau section of the state is forested, and in general both here and in Goiás products of the forest and of miscellaneous vegetable origin are of little significance at present. True, there are large areas in Northern Mato Grosso and Goiás on the slopes towards the Amazon in which untouched rubber-producing trees, both heveas and castilloas, are very abundant, but these are not of any immediate account. On the uplands mangabeira (see p. 140) grows scattered over a wide territory and is exploited for its sap. There is no question of utilizing the timbers of the forest patches now or within measurable time for any purpose except local construction work and for fuel, a statement which is true of almost all the upland areas of the Brazilian Plateau ; the tendency is rather to destroy the forests by burning off than to turn their resources to account. The vegetable world in the western plateaus, however, produces one product of which these regions provide practically the whole of the world's supply. The ipecacuanha plant grows in clumps in moist shady patches in the region immediately south

of Cuiabá and Diamantino in Mato Grosso. It is of slow growth, and has so far resisted attempts to acclimatize it in the tropical parts of other continents, though it is found also in Colombia and probably also in Bolivia.

Such centres of population as there are in Mato Grosso and Goiás are distributed along the crest of the main watershed between the northward and southward flowing rivers and in head basins of these. This great ridge is the natural avenue of approach from the east and has already been followed part way (towards Anapolis) by one trunk railway. On the divide a district has been reserved for the Federal Capital, in the south-eastern corner of Goiás, ready to receive it when at some future time it is removed from the coast nearer to the geographical centre of Brazil.¹ In succession along or near the watershed west of the future Federal District are situated the towns of Anapolis, Goiânia, Cuiabá and Mato Grosso, all well to the south of their respective states. To the north down to the Amazon, and to the south down to the frontier of Paraguay lie vast, almost uninhabited tracts. Except for the single comparatively narrow zone of penetration, the western plateaus and their adjoining lowlands lie beyond the limits of colonization from the eastern coast. Here, however, as in other remote parts of South America, the development of national air transport services is bringing hitherto isolated places into contact with centres of population and economic activity and incidentally enabling the frontier of settlement to be extended. From the map Fig. 10A it will be seen that much of Eastern and North-Eastern Brazil is now covered by a network of air services.

¹ The time for this transfer has now (1958) drawn nearer. Work is in progress on the erection of buildings to contain the new Federal capital to be called Brasília, 600 miles north-west of Rio de Janeiro; but no date has been fixed for the removal.

CHAPTER X

THE BRAZILIAN PLATEAU—THE CENTRAL MINERAL-BEARING ZONE

IGNEOUS intrusion and metamorphism have operated on a larger scale, as already noted, in the Central Eastern States than in any other part of Brazil. There ancient rocks rise to the surface in the high tablelands and serras, and are exposed also in the valleys of the numerous streams that flow in all directions from this central mass. Intrusive mineral-bearing veins occur also in the southern section in Rio Grande do Sul, and are reported to exist in the north-eastern states, but nowhere else in the country are the mineral resources comparable with those in the State of Minas Gerais, which owes its name to the fact that in the days of its early development the district was common mining ground.

All the mining regions in Brazil with one exception suffer from the disadvantage of being situated some distance inland, and of being difficult of access both because of their situation and because of the somewhat rugged relief. Under these conditions gold and precious stones have long claimed the main share of attention. Unfortunately, or perhaps fortunately for Brazil, silver has never been discovered in its territory, gold in no very great quantity nor till fairly late, and diamonds, though in larger quantities relatively than gold, likewise were not discovered till long after the first stages of colonization. When gold and diamonds were at length found, the Portuguese in Brazil showed themselves as keen in pursuit of mineral treasure as the gold-hungry Spaniards had been and were in another part of the continent.

With the exploration of the interior and the development of railways, other minerals besides gold and diamonds have been discovered and exploited to a greater or a smaller extent in Brazil. These include iron ore, manganese, coal, copper, monazite sand and quartz crystals. Except for indifferent deposits of coal and copper in Southern Brazil, and those of gold, diamonds and manganese already mentioned in Mato Grosso, the mineral zone of Brazil is co-terminous with the East-Central region.

In this chapter it is proposed to discuss this region in detail from both geographical and economic standpoints, and to devote only passing attention to other parts of Brazil in which minerals are of some importance.

A study of the relief of the region shows that it consists in the main of high plateau whose general elevation is well over 3,000 feet above the sea, and whose longer axis lies N.N.E. and S.S.W. Along the line of this major axis the São Francisco River occupies a remarkable trough, the bottom of which in the deeper northern section is down to less than 1,000 feet above sea-level, but averages about 2,000 feet in elevation in the southern section. Broad areas of the plateau resembling flattened mountain ranges are thus left on either side of the medial valley (Fig. 18). Towards Central Bahia the São Francisco trough contracts very much in width, the plateau heights facing each other there across it at a distance of about 80 miles. Thus the area to the south is basin-shaped, being entirely surrounded by mountain country of considerable elevation except at the exit of the São Francisco just referred to. The highland mass to the west is broad, but the other masses situated to the south and the east of the valley have been heavily eroded by the headstreams of the Paraná, and by the Paraíba, Doce and other coastal rivers; they thus frequently present the appearance of relatively narrow chains surmounting broader masses of upland. To these apparent chains the general name serras has been locally given, and among the more prominent of them is the Serra do Espinhaço or backbone range, between the Rio Doce and the upper São Francisco, which continues under various local names farther north.

A striking feature in the arrangement of the relief in the region surrounding the main course of the São Francisco is the manner in which the outlying ridges have been left largely detached from the main systems through the erosion of lateral valleys at various angles with, and sometimes even parallel to, the parent rivers. Thus the Altos de Paraná break into the basin between $10\frac{1}{2}^{\circ}$ and 12° S., but this high ridge is separated by a considerable interval from the continuous highlands to the west, the Serra da Matta da Corde projects itself from the southern block well into the valley of the São Francisco between two of its headstreams, and the Serra da Tabatinga and its continuations lie almost at right angles to both the great valley and the western mountains in the latitude of 9° to 11° S.

The State of Minas Gerais in its southern and south-western parts lies in the upper basin of the Paraná. Of the two streams that unite to form that river, the Paranaíba rises in the serras

on the western border of the state and thus forms the boundary between Minas Gerais and Goiás until it is joined by another

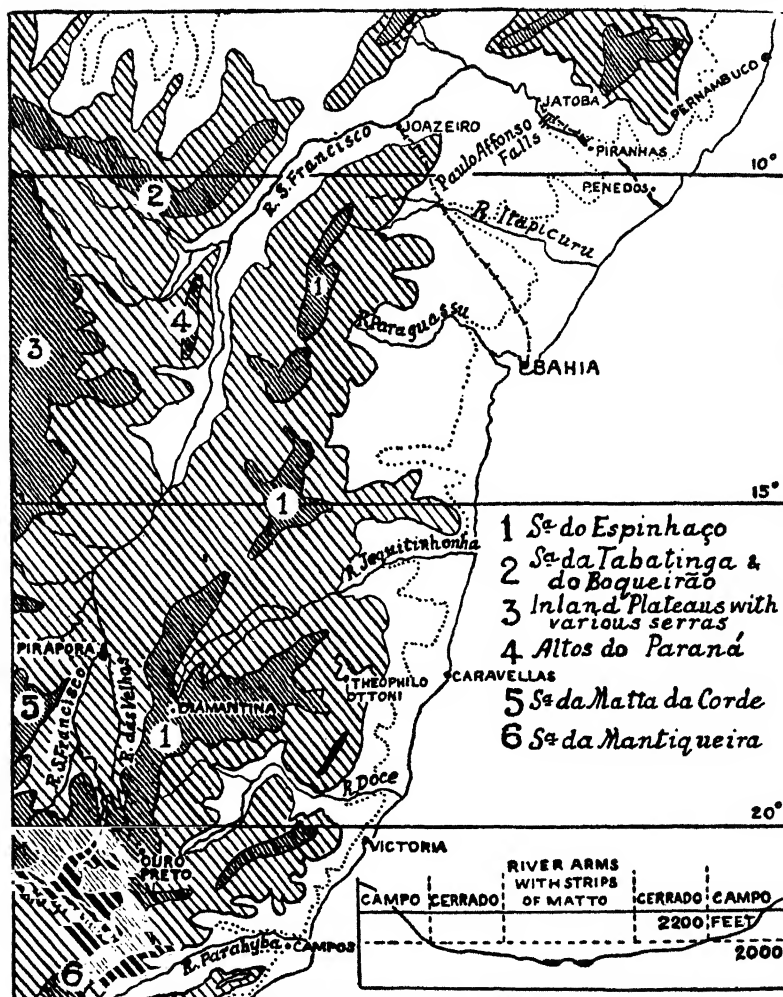


FIG. 18.—The São Francisco Basin and the adjoining coastal region

The dark shading represents the area over 3,000 feet in elevation and the diagonal ruling that between 1,500 and 3,000 feet. The whole of the region shown on the map west of the dotted line is over 600 feet above the sea. Inset a section of the upper São Francisco valley, showing vegetation and other features.

river, the Rio Grande. The Paranaíba receives a number of small tributaries from the mountain country of Minas Gerais, while the Rio Grande, rising in the Serra da Mantiqueira close to

the Atlantic, flows across the southern limb of the state for more than half its course before it becomes in its turn a state boundary.

The heart of the mining region and the most densely peopled area in Minas Gerais, itself the most populous state in all Brazil, is situated in a roughly circular district of some 500 miles diameter in the south-eastern part of the state. It thus lies astride the saddles between the São Francisco Basin and the basins of the Paraná and of the Doce. The most advanced portion of the region is the extreme southern, a small part of which drains to the Paraíba and the greater part to the Rio Grande (see Fig. 23). This section enjoys among other advantages that of being at no great distance from the sea.

The whole upland region in Minas Gerais and Central Bahia has a favourable climate, which, however, does not extend without serious modifications to the lower lying parts of the São Francisco Valley or to the highlands on either side of them. Generally speaking, the temperature is agreeably warm without being unpleasantly hot. The rainfall, though tending to the seasonal and erratic type towards the north, is as a rule sufficient without being excessive. In short, the prevailing climate in the southern section is of the humid warm temperate kind, that favours the growth of forests in the wetter parts and of grasses elsewhere. Thus the vegetation of this region is varied and resembles very much that of the whole Brazilian Plateau described above (see p. 115). On the slopes exposed to the Atlantic in both Minas Gerais and Bahia tropical forests clothe the mountains practically to the summits, and similar forests are found on the high serras that mark off the São Francisco and Paraná Basins and extend as "gallery" forests of varying width along the watercourses elsewhere. In the drier northern regions open forests of a type known as *caatingas* begin to appear, in which trees belonging to the *Leguminosae* predominate. Between these forests and the grasslands pure and simple, there are various gradations, but certain areas in the interior districts, even of this eastern region, are occupied by thorny scrub and low bush with scattered trees. These are the "*campos cerrados*" or closed pasture lands, as distinguished from the open savannahs or "*campos*."

In preparing either the *campos cerrados* or the forest country for pastures or for crops, it is customary to burn off as much of the natural vegetation as possible and to repeat the process from time to time when the original or a degenerate flora re-establishes itself. In this way great quantities of timber which has little value at present, but may be needed in the future, are destroyed. If the population continues to increase in this region as rapidly as it has done in recent years, the time is not far distant when

easily accessible supplies of timber will begin to get short. The fact that the Paulista Railway not far to the south has made large plantations of eucalypts along its track, points in this direction. The practice of burning off repeatedly is probably due in some measure to the need for correcting the acidity of the soil, but since no one ever thinks of using fertilizers, the result sooner or later is that the soil becomes impoverished, at which stage it is abandoned. The same sort of thing goes on all over Eastern Brazil from the Amazon to Rio Grande do Sul.

Four groups of industries, namely stock-rearing, mining, agriculture, and manufactures, are all thoroughly established in Minas Gerais, and the first two of these in the plateau regions of Bahia. Cattle-rearing was the industry earliest taken up and long remained the only one; then came mining at the commencement of the eighteenth century; agriculture rose to a place of importance in the nineteenth century; and since the beginning of the present century manufactures have made their appearance.

With regard to the first of these industries, the early development was due to the abundance of pastures, to the favourable climate, and to the demand for cattle both as draught animals and for meat on the sugar plantations in the coastal districts. Once established, the industry remained fairly prosperous in spite of the vicissitudes through which the plantations passed. Towards the close of the nineteenth century the rise of considerable commercial centres along the coast stimulated the demand for pastoral products from the interior. Besides beef, other products, such as butter, pork, lard and poultry have been added to the list of animal foodstuffs supplied by the plateau regions to such centres as Rio de Janeiro. The building of railways made it possible to transport perishable produce on quite a new scale. Freezing works have been erected on the route of the Central Railway, one at Barbacena in Minas Gerais and another at Mendes behind Rio de Janeiro in the Paraíba Valley, so as to tap the surplus cattle of the region for consumption in or export through Rio. The estimated numbers of cattle, December 1955, were 13.7 millions in Minas Gerais and 4.86 millions in Bahia—over 18½ millions in all, of which at least fifteen, or nearly a quarter of the total for Brazil, must be in the plateau country of the two states, which also contains about one-ninth of the sheep in the whole country.

The mining industry dates from about the year 1700, just before which date the gold deposits of Ouro Preto were discovered. The name given to the town which arose on this field was taken from that of the mountains behind it, which owing to the dark colour of the ores were called the *Serra d'Ouro Preto* (mountain

of black gold). Not long afterwards, in the course of prospecting for gold, diamonds were discovered in Minas Gerais, and the district soon became famous for precious stones as well as for gold.

Gold-mining has been carried on at three chief centres in the state: at Marianna about 10 miles east of Ouro Preto; in the district just south of Sabará and Bello Horizonte, in which the Morro Velho mine is situated, and in the neighbourhood of Itabira do Campo. A branch line from the Central Railway runs to Marianna, and the other two centres are on the railway farther north. Diamonds are obtained from alluvial diggings in various parts of both Minas Gerais and Bahia. Among these are the Diamantina and Grão Mogol districts in the upper basin of the Jequitinhonha, the Bagagem district in the extreme upper section of the Paranahyba Basin, about 250 miles slightly south of west from Diamantina, and the Lençoes district towards the head of the Paraguassu Valley in Bahia, which happens to be the most important source in the world of the black variety of diamonds or carbonados. In spite of two centuries of active exploitation, it is said that the diamondiferous gravels of Brazil are by no means exhausted. As regards production, however, accurate figures are more difficult to obtain than for most other regions of the world, owing to the extensive smuggling of stones out of the country in order to evade the export taxes imposed by the states.

The chief interest in the mineral resources of Eastern Brazil centres in the vast deposits of iron ore in Minas Gerais and farther north in Bahia. The extent of these as yet untouched reserves is not exactly known, but it has been estimated that there cannot be less than 3,500 million tons of hematite ores, including only those analysing at 60 to 70 per cent. of iron, in the Itabirite formations alone of Minas Gerais. These are beyond doubt the largest deposits of high-grade iron ores in the world. The iron-bearing materials fall into four classes: first, rock ore, occurring in massive formations and averaging 68 to 69 per cent. of metallic iron, of which ore the probable yield would be 2,000 million tons; second, rubble ore, consisting of the fragments large and small that have weathered off and lie in huge scree at the foot of the ironstone hills; third, sandy ore, containing a lower percentage of iron, found in the valleys, and due to the sluicing action of rivers upon coarse material; and, finally, an ore known as "canga," produced through the cementation of rubble by limonite into a limestone conglomerate. No attempts have been made to estimate the quantities of rubble and sandy ores, but the figure of 1,710 million tons of 53 per cent. material has been

suggested as the probable yield of the canga formations. A recent authority gives the figure of 12,000 million tons for the hematite ores containing 50 per cent. or more of iron in the whole state of Minas Gerais.

The district in which these iron-bearing formations are best developed is shown in Fig. 19. It extends north-east and south-west diagonally across the Serra de Espinhaço, with a width of upwards of 40 miles and for a distance of about 120 miles from the Guanhões tributary of the Rio Doce along the left bank of the Piracicaba tributary of the same river to some distance beyond the line of the Central Railway. The towns of Belo Horizonte and Ouro Preto lie on its northern and southern edges respectively. The iron-bearing formations here consist of quartzites and clay slates with occasional limestone, the whole overlying the basal complex which crops out at numerous points round the district, and also in a circular area of 15 miles diameter within it situated north of Miguel Burnier. The ore mineral is known as Itabirite, and the series comprising it probably represent sedimentary strata of great age in which the iron was precipitated from water containing carbonate of iron. The change to specular hematite has taken place subsequently through regional metamorphism.

The most remarkable deposit in this richly endowed district is in the neighbourhood of Itabira do Matto Dentro, to which the Vitória and Minas Railway has been extended, and from which two other lines—the Leopoldina and the Central by the Santa Barbara branch from Sabará—are distant less than 50 miles. The first of these is the only one that is likely to be of service for the large-scale export of ores, since the two others have their termini in the congested port of Rio and follow difficult routes. The Vitória route, some 300 miles long, is free from heavy gradients and its terminal port is commodious, and is capable of providing excellent facilities for handling ore. Now that the railway has been relaid and straightened, it is estimated that 1½ million tons of Itabira ores can be exported annually through Vitória. With the vigorous development of domestic manufactures since 1930, Brazil has built up a high-cost iron and steel industry. In 1955 blast furnaces operating in Minas Gerais, Rio de Janeiro, and São Paulo produced about a million tons of pig-iron, their capacity being limited by the scarcity of charcoal used as fuel. Large steelworks have, however, been erected at Volta Redonda in Minas Gerais, 90 miles from Rio de Janeiro, which utilize hydro-electric power and also produce coke (from inferior Brazilian mixed with imported coal) for the smelters. See also p. 167.

There are further deposits of hematite ores, presumed to be extensive, in Western Minas Gerais and in Bahia, in addition to those in Goiás and Mato Grosso. None of these, however, is likely to be utilized for a long time owing to their remoteness from the sea and from fuel. Even those in the São Francisco Valley in Bahia would have to travel by the river either to Juazeiro and then by rail 360 miles to Salvador, or upstream to Pirapora and then more than 600 miles by rail to Rio de Janeiro.

The Brazilian deposits of manganese ores are also in all probability the most extensive in the world, but unlike the iron ores, they have already been exported in large quantities from at least two widely separated districts, both in Eastern Brazil, for some time past. One of these is the Miguel Burnier-Queluz region just south-west of Ouro Preto and close to the Central Railway, and the other is that of Bom Fim and Nazareth not far inland from the shores of the great bay upon which Salvador city stands. The manganese ores in the former are in the Itabira formation on the southern edge of the great iron ore field, and exports have been made by the Central Railway through Rio de Janeiro. Those at Bom Fim, about 30 miles from tide water at S. Felix, were worked for a time, but output has declined with exhaustion of the richer ore. Exports of manganese ores from Brazil reached their highest point in 1917 at little short of 533,000 tons, but figures for later years show a considerable falling off, the exports in 1923 being 235,500 tons and in 1953-55 an average of 146,000 tons.

Deposits of monazite sand, important as a source of thorium, occur along the shores of Bahia and Northern Espirito Santo. They are said to have originated from the muscovite granites and their equivalents in the rocks of the plateau, and to have been concentrated by moving water. So far, only the beach sands have been worked, but it is thought that the known deposits of alluvial material in inland places will yield ten times as much as the reserves in these, and that other alluvial deposits are likely to be found. The old rocks of the plateau in Minas Gerais and Bahia also yield fine quartz crystals, in which Brazil has almost a monopoly of world trade.

In agricultural development Minas Gerais is among the foremost of the states of Brazil. The southern part of the state, though less fertile than the rich area in São Paulo, is of great importance as a source of coffee and tobacco for export, of staples such as mandioca and maize, and of a variety of fresh food materials both animal and vegetable for Rio de Janeiro and the coastal districts. Minas Gerais has become the leading Brazilian

state in the production of maize and follows São Paulo in that of coffee.¹

It stands third among tobacco-growing states, in 1954-55 was second with Pernambuco after São Paulo in sugar production, and it also grows appreciable quantities of cotton. The thinly populated northern parts of the state, however, are of little importance in agriculture outside the São Francisco Valley, and the same applies to the uplands of Bahia. These regions, so far as they are exploited at all, are devoted to cattle-rearing.

In addition to simple manufacturing industries, such as the preparation of dairy products and the extraction of sugar from sugar-cane, the southern district in Minas Gerais has recently seen the establishment of large-scale freezing works at Barbacena and of miscellaneous manufactures of the type common in the great industrial districts of Europe and North America. Among these, cotton textiles are of first importance, and owe their rise at Juiz de Fôra and Barbacena to cheap electrical power. Less progress, however, has been made in the direction of iron and steel manufacture in spite of various attempts to exploit the great wealth in ores. Fuel other than firewood is limited, and thus development has been mainly in secondary manufactures suited to the utilization of water-power for supplies of energy.

Except for the southern parts of Minas Gerais, the whole plateau region in that state and in Bahia still suffers from difficulties of communication and costliness of transportation, as it has done ever since early colonial times. The São Francisco, though navigable for small craft from Juazeiro to Pirapora, has the disadvantages of alternate floods and low water, nor does it provide any direct communication with the sea. Were its valley more developed, it would provide a very useful means of purely internal movement; but in other directions its actual and its potential value are small, since contact with the outside world can be established only by one or other of three expensive routes—either by the short railway on the left bank of the great falls in the lower course, or by the much longer railways from Joazeiro to Bahia and from Pirapora to Rio.

The other rivers which drain these uplands eastwards are useless for navigation beyond the limits of the coastal plain,

¹ The 1954-55 average areas (in mill. hectares) under various crops in the leading states for each are given below.

	Coffee.		Maize.		Tobacco.	Wheat.
Brazil	3·130		5·575		·190	1·14
Minas Gerais	·668		1·125		·032	
São Paulo	1·490		·965	Bahia	·038	
Rio de Janeiro	·055	Rio Grande do Sul	·955		·055	·920
Espírito Santo	·267	Santa Catarina	·245		·031	·143
Paraná	·479		·830			

even if they do not lose themselves in swamps and shallow lagoons near the sea. It is just the same with large streams such as the Rio Doce, the Paraíba and the Jequitinhonha, as with the smaller ones. Thus the only alternative is the building of railways into the mountain country in the interior from the ports serving the populous centres along the coast. The routes available are nowhere easy, and in the south are peculiarly difficult because of the double mountain wall, one before and the other after crossing the Paraíba Valley.

The railway systems from the coastal ports as far as the Itabira iron-ore district have already been incidentally described in the account of the mineral deposits, and the extension of the Central to Pirapora has also been mentioned above. At Bello Horizonte this State Railway changes from the broad gauge (5 feet 6 inches) to the metre gauge. From Sitio, near Barbacena, on the same line, the Western Minas narrow gauge railway branches off first north-west, then north to a point on the upper São Francisco beyond Paraopeba. The Leopoldina system, all on the metre gauge, includes, in addition to the northern extension in the direction of Itabira do Matto Dentro from Entre Rios on the Central, a main line from Rio to Vitória and various subsidiary ones in Eastern Minas Gerais.

Towards the northern part of the uplands of the region, lines have been constructed from Caravellas to Theophil Ottoni (Philadelphia), and from S. Felix due west more than half-way towards the São Francisco. Neither of these railways can be regarded, however, as serving the plateau region proper as yet.

The region described in this chapter, and embracing an area of more than 300,000 square miles, contains altogether less than 14,000,000 inhabitants. Though it is more densely populated than many other parts of South America, it is thinly populated in proportion to its resources. It comprises a variety of climates and great natural wealth, but only one corner of it is developed to any extent. Most of it remains very much as it was when Europeans first saw it, and, until cheaper and more extensive means of transport are devised, will remain so.

NOTE ON RAILWAY NOMENCLATURE

The railway systems of Brazil are now almost entirely State owned; those which were built by British and other external corporations, and were operated under their ownership, had by 1950 been acquired by the Brazilian Government. Some of the lines have been re-named, but in the surveys here of the railway transport systems in Brazil (as well as in other countries) the former traditional names have been retained.

CHAPTER XI

THE BRAZILIAN PLATEAU: THE NORTH-EASTERN CAATINGAS AND SERTÃOS¹

FROM the eastern coastal plain across to the middle Tocantins, and from the northern coastal lowlands to the borders of Bahia and beyond, extends a region which is marked by uncertainty of rainfall and partial aridity. Here the Brazilian Plateau begins to break up, and finally ends in the heights overlooking the Atlantic in Rio Grande do Norte and Ceará, and it is only on these and on the high ridges farther inland that the rainfall is sufficient anywhere, except on the coastal strip, to support forests of the evergreen tropical type or to allow agriculture to be carried on without great risk of crop failure through droughts. The area in which these conditions hold comprises the upland in the four north-eastern states, also in Piauí, Alagoas and Sergipe, and in South-Eastern Maranhão and Northern Bahia.

The inhabitants of the north-eastern districts have given distinctive names to the various zones of vegetation that are encountered on travelling inland from the coast. These zones correspond to changes in the elevation and the amount of the rainfall. The relatively well-watered coastal lowlands, averaging from 30 to 40 miles in width, where tropical crops can be grown, are called the *matta*; there the original vegetation was forest, thin in most places. The intermediate parts of the plateau behind the *matta* are called *agrestês* and *caatingas*, the second of these names being used to denote the open stands of rather short and thorny trees and plants, including cacti, that have adapted themselves to these dry areas. Above the *caatingas* are the *sertãos*, covering very wide areas in the interior. The natural vegetation consists of brushwood and grasses, interspersed with belts and patches of *caatinga*, among the stunted trees of which grass also grows. On the *serras* yet another zone of vegetation, namely, true forest, is found on elevations above 3,000 feet.

¹ The Brazilian plural is *sertoês*. Both *sertão(s)* and *caatinga(s)* are spelt throughout this book with anglicized plurals, to indicate their generic regional rather than their specific Brazilian senses, in which *sertoês* denotes the somewhat primitively rural backlands of the Plateau.

In spite of the more or less insufficient rainfall at the present day, the region as a whole has suffered heavy denudation. This process has been assisted by the thin cover of vegetation and by the fact that the rain comes mainly in heavy downpours with storms. The rate of the run-off is thus abnormally rapid and the

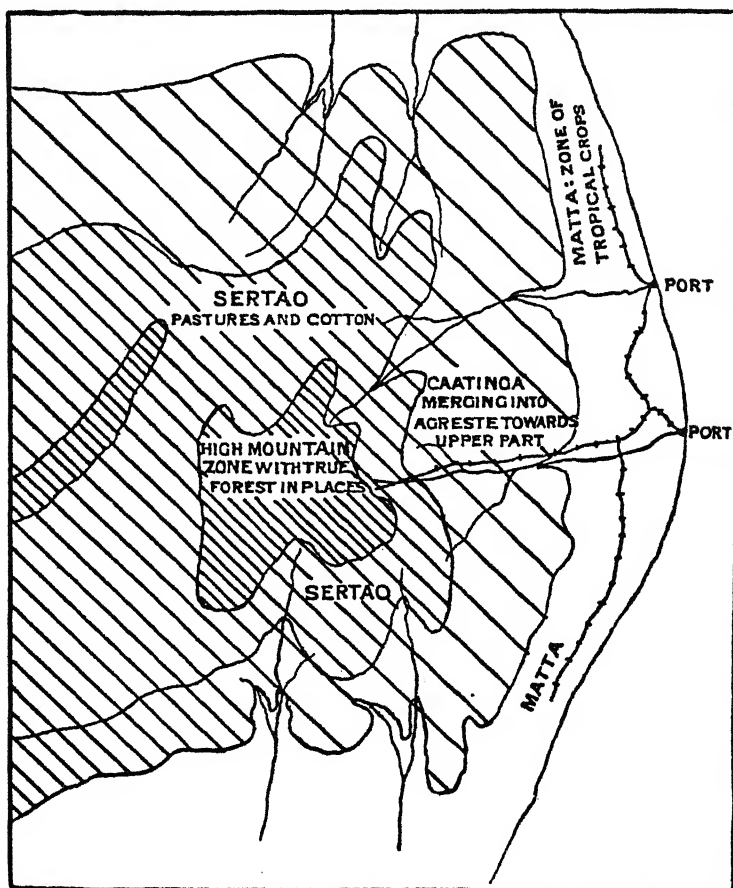


FIG. 20.—Regional Diagram of North-East Brazil

erosive power of the streams correspondingly high. On reaching the lowlands these have their currents suddenly checked, and are unable to carry out to sea the whole of their burdens of debris. As a result they have deposited vast quantities of sand, forming waste stretches along the coast, and blocking their mouths so as to make them inaccessible by ships.

Geologically, the region consists of the same two elements as are found over much of the rest of the plateau of Brazil. The basal rocks are the ancient crystalline and metamorphic series so well developed in the east-central region. These are overlaid extensively in the higher parts by sedimentary beds in which sandstones and limestones predominate. The generally high porosity of these uppermost rocks in the interior is an adverse factor in the serviceableness of the rainfall to vegetation.

In relief the region is far from uniform. Three main and somewhat broad valleys have been carved out of the plateau mass by the chief river systems—the Parnaíba; the Iguaíbe and parallel streams in Ceará and Rio Grande del Norte; and the lower São Francisco, together with the Vasa Barris and the Itapicurú. Between the Parnaíba basin and those of the rivers to the east there remains a broad belt of upland rising to 2,000 feet in the Serra do Piauí and other ridges beyond it to the north, extending more or less continuously almost to the coast. Again, between the basin of the Assú River and that of the São Francisco, below the bend in the latter river, stands a roughly triangular and fairly compact block of uplands, a considerable part of which exceeds 2,000 feet in height. The most striking ridge here is the Serra da Borborema, which roughly bisects the states of Rio Grande do Norte and Paraíba. A number of smaller rivers, in addition to those already mentioned, take their rise in these two great systems of uplands and find their way by short courses to the sea. Some of them—for example, the Rio das Piranhas in Rio Grande do Norte, the Paraíba do Norte in Paraíba State, and the three rivers that empty themselves into S. Marcos Bay in Maranhão—have been sufficiently powerful to excavate valleys of some size and depth back into the plateau.

The main climatic features of the region as a whole have been discussed in Chapter II, and the general distribution of the vegetation has been referred to above, but some further details under these important heads require to be given to complete the account.

In the first place, it has to be noted that though the average rainfall over the region as a whole is deficient, this is not because of the scantiness of the total precipitation (see Fig. 21). This has been made clear by systematic observations that have recently been carried out on the spot by a special department of the Brazilian Government.¹ A relatively small area, extending

¹ A department called the *Inspeccoria de Obras contra as Seccas* was set up some years ago. One of the first tasks it has undertaken has been an exhaustive study of climatic conditions in the north-east. Various reports have been published by Dr. J. de S. Ferraz, Director of the Meteorological Service of Brazil.

diagonally south-west from the mouths of the Assú and Mossoró Rivers, receives a rainfall of less than 20 inches per annum. Far the greater part of the region has a rainfall of from 25 to 50 inches

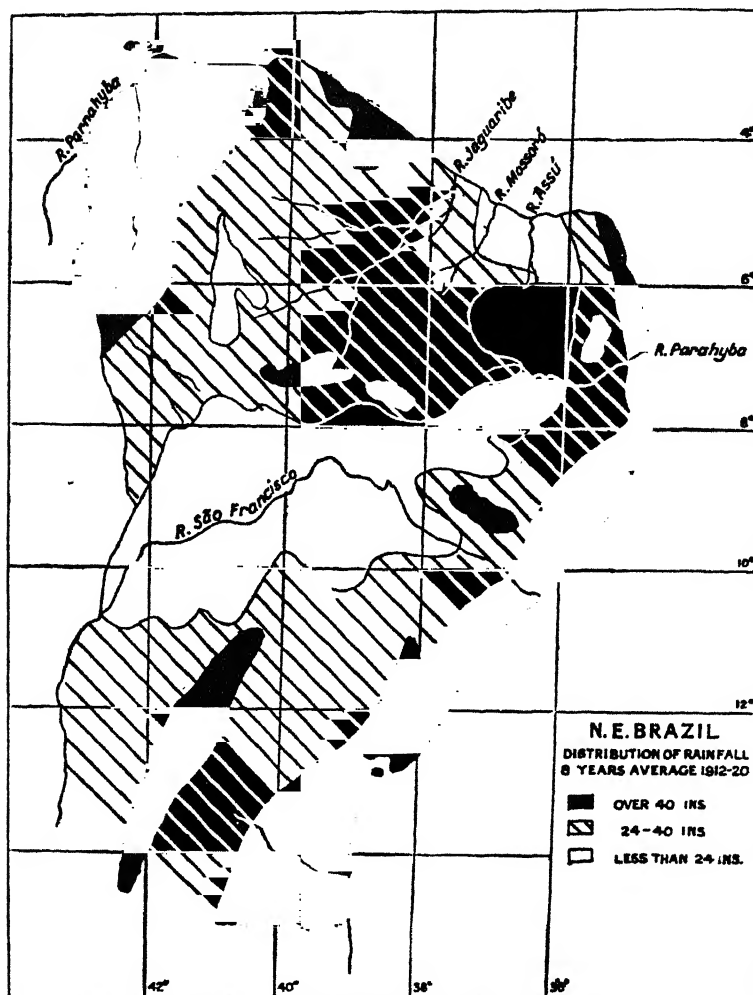


FIG. 21.—Rainfall in North-East Brazil

on an annual average. The troubles of the N.E. plateau area lie in the fact that the rains are badly distributed as to seasons, as to districts and as between one year and another; they are confined as a rule to the months from January to April, and come with violent storms, sometimes even causing great damage

by floods, which are all the more destructive because the water drains with extreme rapidity from the parched soil bare of vegetation. Moreover, in some years the rains fail altogether and terrible droughts occur, such as those of 1824-25, 1844-45, 1877-79 and 1888-89 in the last century, and the less severe ones of 1900, 1915 and 1928-29 in the present century. Owing to the latitude and the general physical conditions in Ceará and the neighbouring states, a rainfall in any year of less than 800 mm., or $31\frac{1}{2}$ inches, means arid conditions. On the other hand, a winter rainfall of more than a meter is likely to be harmful. Between occasional floods and recurring droughts, North-Eastern Brazil is sorely tried, and perhaps merits the name Brazilians have given it of Job of the North.

A second feature to be noted in connection with the climatic geography of the north-eastern region is that the area of lowest rainfall in Rio Grande do Norte, Paraíba and Ceará, is succeeded towards the south-west and the interior by a large one of moderate but insufficient rainfall extending from near the Atlantic coast in the valley of the lower São Francisco to the region of the Tocantins; and further, that a broad extension of the second area runs up the valley of the main course of the São Francisco, including the uplands on either side, especially towards the east (Figs. 5 and 6). Thus sertãos are found on the flat uplands all the way from Rio Grande do Norte to the northern border of Minas Gerais. Though, as would be expected, there is a recognizable correspondence between the relief and the rainfall, the latter being generally less in the lower areas of the river basins, yet semi-arid conditions tend to prevail even on the higher uplands towards the Atlantic, but give way to those of regular summer rainfall with tropical calms towards the valley of the Tocantins in the west. The sertão and caatinga region of the north-east owes its peculiar climate to the existence of the great permanent equatorial low-pressure area of Amazonia behind it. As long as the dry S.E. Trades sweep in from the ocean towards that basin, the sun shines pitilessly in the North-East; only when they retire south do calms bring rains.

In the third place, during the long dry summer season,¹ when the skies are clear and the temperature over 80° F. on the northern sertãos, the rate of evaporation from any surface water is intense. Thus the rivers all tend to run low, and some of them in the extreme north-east dry up altogether. Even a large river such as the Parnahyba, towards the west and normally navigable, becomes at times practically useless for traffic, while the São Francisco to the south, deriving its main volume from the well-watered heights of Minas Gerais, gets quite low at times. Owing

¹ In North-East Brazil, the term summer season means the dry season.

to the summer flooding characteristic of this river and to other features of resemblance between it and the great African river, the São Francisco has been called the Brazilian Nile; projects have been proposed for utilizing its waters for the irrigation of extensive tracts in its lower valley.

Fourthly, the natural vegetation of the north-east on all intermediate elevations between the coastal plain and the mountain heights is xerophytic in character. It becomes dormant during the summer. Many of the trees bear pods from which the hard seeds fall to the ground ready to germinate when the next rains come. The cacti store water in their stems and leaves, and are sometimes cut down in order to obtain this when droughts are severe. The grasses dry off during the summer heat, but revive quickly when the ground becomes soaked by rain-water. Crops can be cultivated only in favoured situations in the river valleys. Even there mandioca and maize, which together with beans and meat form the staple food of the people, fail from time to time, and famine conditions then arise. The growing of food crops is an inconvenient necessity in this region of great areas of grasslands, from which is derived most of such wealth as the inhabitants possess. There it is truer than in most other parts of the world that all flesh lives on grass. In various parts of the sertão, however, as will be seen later, three different kinds of useful plants grow wild and are partly cultivated, and the industries which these provide, though relatively small, serve in some measure to relieve the inhabitants of the districts in which they grow or are grown from an exclusive dependence upon the poor natural pastures for their living.

In a region where man is engaged in a close struggle with relentless forces of nature, the economic structure tends to be primitive and such industries as are pursued show a close correspondence with variations in the environment from place to place. Mining and manufactures, which can be carried on in regions where the climate is unpropitious and agriculture uncertain or impossible, scarcely exist in the North-East of Brazil. Mineral deposits have been reported to exist in the interior, but nothing has been done to exploit them. A certain amount of salt is collected from the dry depressions near the sea along the northern coast of Rio Grande do Norte, but that represents the sum total of the mineral output from the whole region.

The main industry is naturally stock-rearing. There are nearly 6 million cattle in the north-eastern states exclusive of Bahia, and upwards of $5\frac{1}{2}$ million goats. The cattle kept are of a hardy but inferior kind in which the zebu strain is prominent. The surplus animals are either marketed in the plantation districts

near the coast, or find their way by sea to Pará and other Brazilian ports. As in other semi-arid lands, one of the most valuable export products derived from the cattle of the sertãos is hides, which are dispatched in large quantities from Fortaleza and other northern ports. Cattle-rearing in this region is organized on large-scale lines on great estates, each of which is largely self-sufficing as to food supplies in ordinary times. Attached to these estates are small colonies of permanent settlers called *mora-dores*, whose business it is to cultivate the food crops necessary for the whole patriarchal community. The herdsmen are mainly

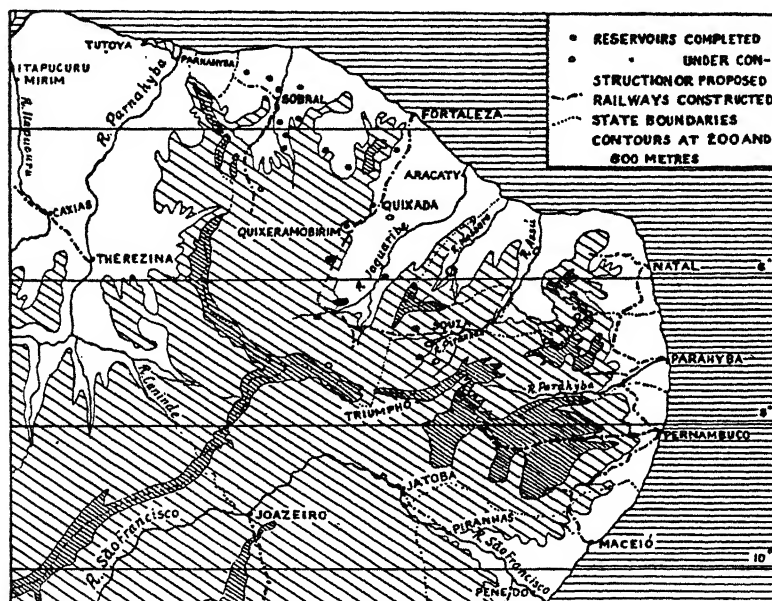


FIG. 22.—North-East Brazil.

of Indian blood, but vigorous and very tenacious. They still dress themselves in the picturesque outfit of leather, and fit flaps of the same material over their horses' heads, both of these as a protection against the thorny scrub vegetation which must frequently be traversed in pursuit of the cattle. Towards the coasts of these northern states where relatively high and better-watered ridges rise from the sertãos, there is a striking contrast between the herdsmen of the flat country and the mixed farmers of the serras. In the former region the cattle roam at large and the small areas under crops are fenced in; in the latter the fields are open and the few cattle are tethered.

In order to mitigate the worst effects of the recurrent droughts the Federal Government has recently undertaken the construction of reservoirs at various places in the north-eastern region. The first was completed in 1906 and since then more than forty others have been built on public account in addition to a number of smaller private ones. Some of the former are quite large, the Cedro reservoir at Quixada having a capacity of 161 million cubic metres. These reservoirs are to be utilized in three different ways: first, to provide drinking-water for live stock, and if necessary for the population also; second, to furnish irrigation water for the cultivation of food crops such as mandioca, beans and maize, and fodder crops for the cattle; and third, as the water in the reservoirs falls, the margins can be used for growing crops like rice. According to recent reports the work of fighting the droughts in the North is being seriously undertaken in a relatively small area in Ceará and the states east of it. There roads are being laid out as a means of concentrating live stock when necessary in the neighbourhood of the water supplies.

In one way the construction of large storage lakes is easy, since the streams frequently find their outlets from the plateau country by narrow gorges or by series of gorges. On the other hand, the areas to be served cover immense spaces, and in a region where evaporation is intense, more than ordinary care has to be taken to make the reservoirs as deep as possible; shallow ones would be useless as a means of tiding over the worst visitations, and these after all are what have to be considered; the strength of the chain depends upon that of its weakest link.

The rearing of goats stands next to cattle-raising among the industries of the sertão, especially in the two states of Ceará and Piauí. In fact, this dry northern region is one of the more important sources of goatskins in international trade. The goat being an animal which cannot be bred to produce meat and milk and at the same time skins of a high quality, it is easy to understand how these semi-arid districts, specializing in the latter product, are able to furnish a better article than most other goat-rearing lands. As is well known in the Old World, goats are adapted to the dry regions towards the desert borders, and it is not surprising that Mediterranean and North African strains should flourish in this part of the New World.

Apart from stock-rearing, the north-eastern sertãos have developed industries connected with three different types of indigenous plants, namely cotton, the carnaúba palm, and manihot and mangabeira rubber-producing trees.

The first of these plants is of considerable importance in the

region under discussion. It is grown not only on the sertãos, but also on the hills rising from the coastal plain. The commonest species is a long-staple arborescent variety. Provided sufficient moisture is available, this region is admirably suited to cotton-growing, since the plant seems to prefer the dry climate of places on the margin of other cultivations and cannot stand frost, which of course is unknown in North-Eastern Brazil. Nearness to the Equator there is to some extent compensated by the moderate elevation of the cotton districts above sea-level. At all events the region is free from the two extremes, undue cold and steamy heat, both of which are fatal to successful cotton cultivation. It has been said that the area under the crop could be greatly increased in the north-eastern states, given sufficient irrigation. The success that has attended the cultivation of cotton in Peru (see p. 78) under similar but even drier climatic conditions, would lend support to this statement.

Cotton-growing has long been established in this part of the country. Towards the close of the eighteenth century Brazil was one of the foremost cotton producers in the world, but the invention of the gin in 1793 greatly sharpened the competition from North America and the sertão product got left behind. Brazil now produces over 400,000 metric tons of raw cotton, nearly 6 per cent. of the world's total, and almost four times as much as Peru, the only other important cotton-growing country till recently in South America.¹ Of the Brazilian total over one-third still came in the years 1954-55 from the north-eastern area; though the output of short-staple upland cotton from São Paulo State has expanded notably with the increased consumption of local mills (see p. 152).

Among the sertão states five, namely Ceará, Paraíba, Pernambuco, Rio Grande do Norte and Maranhão in order, lead in cotton cultivation. In the North-East cotton is grown almost always between the contours of 500 and 2,000 feet on lands where the rainfall is light or uncertain and where there is little competition from other crops. Though the annual variety is cultivated in favoured districts, very large quantities of cotton are obtained from the tree variety which can tolerate relatively dry climatic conditions and which is adapted to the soils derived from, or underlaid by, sandstone and limestone rocks that cover large areas in the north-eastern uplands. The progress of the industry in the sertãos is hindered by a lack of sufficient labour and capital, by the primitive and slipshod methods of cultivation, by failure

¹ Cf. p. 198 for recent developments in Argentina.

to grade and bale the product properly,¹ and by the appearance of the boll weevil, which is likely to be troublesome in a region where little is known of the application of science to agriculture. The periodic droughts, too, are apt to cause serious downward fluctuations in the yield, though as in other similarly afflicted but naturally fertile areas, these visitations in the cotton districts are marked by periods of active recovery.

The carnaúba palm is an interesting kind of drought-resisting tree that grows wild over extensive regions in the sertãos and caatingas of all the north-eastern states, but particularly in Ceará, Maranhão, Piauí and Rio Grande do Norte. The most valuable product which this useful plant yields is the wax, obtained from the young leaves and exported to the United States and Europe, where it is used for electrical insulation work. In Brazil the wax is utilized as a substitute for candles. Various other parts of the carnaúba palm are turned to account in the interior regions of the North-East; the fruit and the pith provide food materials. the stems are sawn up for timber, and the leaves are used for roofing purposes.

Unfortunately the demand for the various products of the carnaúba palm tree has led to the wholesale destruction of the trees growing wild, and as yet plantations have been established only on a small scale. In this industry as in so many others in North-Eastern Brazil, shortage of labour appears to be a serious obstacle to progress. The relatively sparse population is insufficient for, and is totally unfamiliar with, the modern methods involved in the conservation of natural resources and underlying the processes of adding thereto by plantation husbandry. Largely of Indian stock, these people find it difficult to change the habit inherited from untold generations of ancestors of taking without thought for the morrow what nature offers at hand.

The exports of carnaúba wax from Brazil increased from less than 4,000 metric tons in 1913 to an average of over 6,700 in the three years 1928-30, and of 10,730 in 1954-55. Nevertheless, the carnaúba palm has, like the cinchona tree before it, been successfully acclimatized in plantations in Ceylon, and it is possible, therefore, that the same fate may overtake this South American industry as has already befallen that of wild rubber.

Two kinds of rubber-producing plants are native of the north-eastern states, namely the maniçoba (*Manihot glaziovii*) and the mangabeira (*Hancornia speciosa* and other species). The first of these flourishes in the caatingas of Ceará, Rio Grande do Norte

¹ However, the Federal Government has recently established grading stations in Pernambuco, Maranhão and Ceará, as well as in São Paulo.

and other neighbouring states. The product of this tree is known as Ceará rubber and realizes an inferior price owing to the frequent presence of moisture and of impurities such as sand incidental to its collection. The second, mangabeira, also grows on lands above the coastal margin, but more particularly on the chains in the interior of all the north-eastern region down to Bahia, in which state there are also plantations of mangabeira trees. The industry of collecting the latex from both these kinds of trees has suffered in common with the whole rubber industry of South America, and it does not now amount to much importance in the economic life of the regions affected.

The trade of this whole north-eastern angle of South America is concentrated largely in some half-dozen ports, among which Salvador (Bahia), Recife (Pernambuco), and S. Luis in Maranhão are the chief, followed by João Pessoa (formerly Parahyba), Fortaleza, Natal and Maceio. These ports serve both the plantation areas along the coastal lowlands where sugar, cacao, coffee and rice are grown, as well as the interior. In general there is a deficiency of good harbours between Salvador and S. Luis owing partly to the unbroken nature of the coast, partly to the fact that at the mouths of the rivers there are few good estuaries, and partly also to the fact that a reef of coral limestone lies close to the shore of the three north-eastern states. Exposed as the coasts are to the north-east and south-east trades, ample protection is necessary for shipping if goods are to be handled expeditiously, and in the absence of natural havens it is difficult to construct sufficiently sheltered and enduring artificial ones.

Coastal steamers of various lines, in particular of the Lloyd Brasileiro, make regular calls at the above-mentioned ports, but foreign ocean-going vessels use only two of them as a rule, namely Recife and Salvador. In spite of its nearness to the great highways of commerce on the Atlantic, the region as a whole remains somewhat cut off from the outside world.

With regard to internal communication the North-East suffers from the scarcity and the poorness of its navigable rivers. The São Francisco is accessible to sea-going vessels only as far as Penedo, and beyond that to river craft only as far as Piranhas. The Paraíba River is ascended with difficulty up to the town João Pessoa 15 miles from the mouth. All the rivers entering the sea along the north coast in Rio Grande do Norte and Ceará, with the exception of the Assú, either have sandbars at their mouths or dry up during part of the year. The Parnaíba ends in a large delta in which only the western branch of the river offers accommodation for shipping, and that indifferent, at

Tutoya ; and above the delta, though nominally navigable for river craft to the Caninde confluence, the Parnaíba is often too shallow to permit of traffic. The three rivers entering the opening in which Maranhão Island stands are a little better ; they can be navigated for considerable distances direct from the sea inland during the wet season, but are obstructed by sandbanks at other times.

In these circumstances the chief means of internal communication must be roads and railways ; but the spaces to be served are immense, the population sparse, and the traffic small. Road-making in the North-East, however, does not offer the same difficulties as are encountered in the humid and densely forested parts of Brazil, and some progress is being made in the direction of linking up inland centres in this way, especially as noted above in connection with the irrigation works.

The existing railways consist for the most part of lines that strike inland from the leading ports. That from Salvador to Joazeiro on the São Francisco, already mentioned in the preceding chapter, taps the sertãos of Northern Bahia, and, by means of the São Francisco Valley, the interiors also of Pernambuco and Ceará. Eventually, in fact, the Cearense line from Fortaleza, which has now reached the southern border, will be prolonged to a point on the river opposite Joazeiro, which may then become an important port ; for it already serves as an outlet for the middle São Francisco Valley above it, where cattle-rearing and cotton-growing industries have recently been established. This last region is apparently a rich one, and is, in fact, according to some authorities, the most promising cotton area in Brazil.

From Recife as its headquarters, the Great Western Railway of Brazil built lines that strike north and south through the rich matta region to João Pessoa and Natal on the one hand and Maceio on the other, and that send off several branches inland. From Recife and João Pessoa also, lines have been built westwards into the sertão region ; and when connection is eventually established with the Ceará Railway either via Triumpho or farther north via Souza, the whole roughly rectangular region to the north-east will be headed off and no point in it will be more than 100 miles from the sea or from a railway line. The main Cearense line leaves unconnected the port of Aracati at the mouth of the Jaguaribe to the east, and is not very fortunate in its terminus at Fortaleza, where sand has completely silted up the old harbour ; but improvements are in hand which will move the accommodation for shipping about a mile farther out to sea, the necessary link being provided by means of a railway extension.

In Piauí the indiffent waterway of the Parnaíba River, the basin of which forms the State, is the chief means of internal communication. It links the port of Parnaíba at the head of its delta with the capital town, Teresina, 200 miles inland, which now, however, has through railway connection via Caxias with S. Luis in Maranhão. In this thinly populated state, as in the interior of the North-East in general, roads, acting as feeders to, and linking up the existing railways, are more serviceable than extensions of the railways. Here, as in many other parts of the world of broken terrain and scattered settlement, developments in transport are now mainly in the forms of road motor and air services.

CHAPTER XII

THE BRAZILIAN PLATEAU—THE COFFEE REGION

ABOUT 60 per cent. by value of the exports of Brazil in inter-war years consisted of coffee, and over 55 per cent. still consists of this product, over nine-tenths of which is grown in the states of São Paulo, Minas Gerais, Paraná and Espírito Santo. This, the greatest coffee region in the world, is centred mainly in São Paulo state, and northern Paraná; but connected with this through the Paraíba valley, where planting was first established, is another area in south-eastern Minas Gerais and the adjoining southern districts of Espírito Santo. The main areas of plantations in São Paulo, Minas Gerais and Paraná (Fig. 23) produce about 80 per cent of the total crop. In this chapter it will be convenient to describe the whole area from the Atlantic coast of Rio de Janeiro and of São Paulo to the valley of the Paraná in the west.

On the south-eastern side the Serra do Mar and its continuations rise steeply from the Atlantic everywhere except along a short strip between Rio de Janeiro city and Cape Frio, in the district round Campos near the mouth of the Paraíba, and again in the south at the mouth of the Ribeiro River. Behind the Serra do Mar lies the parallel valley of the Paraíba, deeply entrenched towards the east, but rising to the general level of the plateau near the city of São Paulo. Thus anywhere east of that centre two ascents are necessary to gain the plateau, while from there south-westwards only one is necessary. Between the Serra do Mar, however, and the Serra do Paranapiacaba the eastern edge of the plateau sinks in elevation to less than 3,000 feet, and through this gap passes the only direct railway from the sea to the highlands, that from Santos to São Paulo.

Beyond the summit of the main eastern edge of the plateau in the Serra da Mantiqueira and its southern prolongations, the relief inland is not interrupted by any marked unevenness. The rivers drain westward by relatively long courses to the Paraná. Ridges are left standing above the general surface here and there, but their outlines are rounded and nowhere do they form serious

barriers to movement: as the rivers gain in volume and force beyond the eastern section of the plateau, they tend to cut valleys whose floors are below the general surface and thus cause the western region to be one of a succession of ridges and hollows whose general alignment is S.E. to N.W.

Geologically the region consists of much the same elements as are found in other cross-section areas of the eastern half of the



After H. O'R. Sternberg, by permission of *Geographical Journal*
FIG 23.—The Coffee Region of São Paulo and adjoining States

Brazilian Plateau. The basal system of ancient crystalline rocks and their allies rises to the surface in the eastern mountain slopes, but inland, diabasic lava sheets cover large areas with their reddish products of decomposition and lend exceptional fertility to the soils. Sedimentary rocks occur in the west and again towards the south, where Permian coal-bearing deposits crop out along a narrow band extending from Itapetininga into the neighbouring state.

The climate of this part of Brazil in common with other eastern districts is marked by two zones corresponding to differences in elevation. Along the narrow strip of coastal lowlands and on the seaward slopes of the plateau, humid tropical conditions prevail and the vegetation is the dense evergreen forest of such situations. The eastern parts of the plateau stand at an elevation of upwards of 3,000 feet, and are exposed to the easterly rain-bearing winds which ensure an ample, but not excessive, rainfall. The situation of these eastern districts on the outer margin of the tropics, combined with their elevation, causes the climate to be warm, temperate and equable, invigorating and yet favourable to a rich and varied vegetation, frosts and extreme heat both being rare. The heights were originally covered with mixed forests containing hardwood trees of the laurel, myrtle, and other families, together with an undergrowth of tree ferns, bamboos and shrubs. In some places there were more or less open tracts of savannah, especially just beyond the eastern ridge.

Towards the interior, the climate becomes less uniform over the area owing to the changes in elevation between the river valleys and the intervening ridges. On the latter there are stretches of open country reaching almost to the great valley of the Paraná, but elsewhere the country is forested. Towards the Rio Grande mixed hardwood trees prevail, while from the line of the Tieté stretches the Paraná pine forest away southwards through the states of Paraná and Santa Catharina. In São Paulo this forest is highly mixed. "The stands are usually four-storied, with *Araucaria* only in the upper story, 80 to 120 feet tall; a second story, 60 to 80 feet tall, of hardwoods, about 50 per cent being various species of the laurel family; a third story, with a large number of species predominantly *Lauraceæ* and *Myrtaceæ*, 30 to 60 feet tall; and an understory of tree ferns, bamboos and maté, mostly 10 to 30 feet tall."¹

The forests of Paraná pine (*Araucaria brasiliensis*) do not attain their best development for cutting purposes in this region. Farther south, more or less pure stands, free from undergrowth, are of more frequent occurrence, and it is there that the timber industry has made most progress.

Apart from the exploitation of the Paraná pine, the region under review makes little economic use of its forest resources except for local construction and fuel requirements. Far more timber is consumed as firewood throughout Eastern Brazil than is utilized for all other purposes combined; coal is almost unknown in the interior and even the railway locomotives have

¹ "Forest Resources of the World," Zon and Sparhawk. New York, 1923.

been run on wood fuel. In São Paulo hardwood trees and Spanish cedar are cut for timber, but the exports of wood derived from these trees amount to very little. In fact, easily accessible stands are beginning to get inadequate to domestic consumption in the populous eastern parts of the state.

Among the other industries agriculture, stock-rearing and manufactures account for nearly all. The rich mineral region of Minas Gerais reaches its southward limit north of the Campos-Rio Grande line; no deposits of any importance have been discovered in Rio de Janeiro State, and those of São Paulo are confined to extensive but little worked beds of magnetite iron ores and to poor seams of inferior coal in a limited area in the extreme south.

Though the cultivation of sugar, beans, rice and cotton, and the rearing of cattle claim some attention, and though manufactures have recently developed in a remarkable way, the main industry of the region and the greatest in all Brazil as judged by the value of the exports is coffee-growing.

In Central and Northern São Paulo and in the adjoining districts of Paraná and Minas Gerais the relief, the climate and the soils combine to favour the cultivation of the crop for which these districts are famous. Other parts of the tropical world—the Andean slopes of Colombia and Venezuela, Guatemala, Southern Arabia, and Abyssinia—produce coffee, and several of them coffee superior in quality to the Brazilian, but none of them possess such extensive suitable areas. Brazil alone produces 40 to 50 per cent. of the world's coffee and the state of São Paulo about one-fifth.

The industry was introduced into Brazil about 1870 and advanced till about the year 1908, when it became apparent that saturation point had been reached in the world's markets. The rapid expansion of coffee-growing in the São Paulo region has been due to various special causes in addition to favourable geographical conditions. The soils are rich in iron, a mineral that the coffee plant requires to be well supplied with. The areas covered by suitable soils and otherwise favoured by nature are so extensive that when land which has been under coffee for some years shows signs of exhaustion, it is either turned over to other crops or is abandoned, and fresh land is cleared for cultivation. The berries on each plant all ripen at the same time, so that the harvest can be carried out in a single operation, whereas in other regions several pickings are necessary. The climate, being moderately cool, is well suited to Europeans and is sufficiently invigorating to encourage bodily activity. The inhabitants are an active race, descended so far as the nucleus is concerned from the original

Portuguese settlers and the Indian tribespeople they found there, the latter being among the finest native races in South America at the time of the conquest. Further, to meet the enormous demands for labour on the coffee plantations, Northern Italians have been encouraged to migrate to this region in order to make good the gap in the labour supplies caused by the emancipation of negro slaves between 1880 and 1890. It is difficult to think how the coffee-planters could have managed without these additional work-people, who on many of the plantations provide the whole of the labour. The demand for Italian labourers has been so strong that the State of São Paulo has spent considerable funds by way of shipping subsidies and of advertising propaganda in order to induce as many as possible to come to work on the coffee plantations. Finally, the coffee industry in São Paulo and elsewhere in Brazil has been materially fostered by the Federal Government's valorization schemes.

So closely has the whole economic fabric of Brazil been bound up with the coffee industry that when over-production has occurred or has been threatened, the Federal Government has stepped in and financed the holding of, or has purchased and destroyed sufficiently large quantities of the crop to relieve congestion on the international market. Although this procedure of the Brazilian Government rather encouraged than discouraged over-planting and over-production in the long run, and certainly assisted Brazil's coffee-growing competitors, it tided over the disasters that threatened Brazilian producers consequent upon throwing larger supplies upon the world's markets than could be absorbed without fall in price in years of abundant harvests. The yield of coffee plantations in Brazil is especially liable to marked fluctuations, and the valorization schemes were justified in so far as they contributed to orderly marketing; they broke down because they failed to adjust supply to effective demand.

In response to the indirect encouragement given by the valorization policy, the area under coffee expanded in the period 1920-30 both in Brazil and also in other countries taken together. The results, in combination with the world-wide trade depression of 1930-32, were over-production and a disastrous fall in the market price. In order to meet this situation the Brazilian Government set up the National Coffee Department (which existed from 1931 to 1947) with control over the whole industry for the purpose of maintaining equilibrium in the market. Financed by means of an export tax, this body proceeded to acquire surplus stocks which it eventually destroyed if they could not be unloaded without depressing the price, the total quantity thus eliminated

down to December, 1943, being 77·8 million sacks. After the late war period of restriction of exports by quotas agreed to by all Latin-American producers, Brazil is again faced with open competition and the problem of surplus production. The existing coffee plantations are, in fact, capable of producing larger supplies on an average than the country's smaller proportion of the relatively inelastic world demand for Brazilian coffee.

In São Paulo State the area of coffee cultivation has spread northwards and north-westwards from the district near the capital, until now the town of Ribeirão Preto is a most important local centre, the geographical centre of the whole specialised region lying between that town and Rio Claro (see Note, p. 154). The smaller area in Southern Minas Gerais is some distance to the east of the main one in São Paulo, but the whole industry centres on the city of São Paulo, which has grown amazingly in size and importance; it now has over 3 million inhabitants and is the second city in South America. From São Paulo railways branch out radially to the north, north-west and west, each of them serving a definite zone. Of these the most important are the Paulista, the Mogyana and the Sorocabana, which extend in the same directions respectively as the points of the compass mentioned above. In addition to the heavy traffic in coffee, amounting to several million bags yearly handled by each, these railways together with others transport large and increasing quantities of raw cotton and cane sugar, as well as numerous cattle brought in from the interior and fattened in the north-western districts of the state. All these bulky products tend to be concentrated in the first instance at São Paulo, whether destined for the export trade or for domestic consumption.

From São Paulo a very important railway runs south to Santos and another line belonging to the Central System runs east to Rio de Janeiro (see p. 56), so there is a choice of two seaports for the export trade. Much the greater proportion, however, is consigned by the shorter route to Santos. (See Note, p. 154.) As the volume of traffic has grown beyond the capacity of this double-track electrified railway, two additional tracks are under construction.

The port of Rio de Janeiro derives most of the coffee it handles from the districts in the Paraíba Valley and in South-Eastern Minas Gerais, for which it is the natural outlet. The former of these districts is naturally fertile, though now partially exhausted. The valley has a broad floor which has long been cultivated for food crops. The steeper sides are still clothed with the tropical forest that originally covered the whole depression, but the gentler slopes as well as the whole upper valley are now

planted with coffee. A railway starting from Cruzeiro, less than half way between Rio de Janeiro and São Paulo, ascends into the plateau of Minas Gerais by the Rio Verde Valley, and the Central of Brazil, mentioned in Chapter X, does so in a general northerly direction from Rio de Janeiro. This city accordingly taps the south-eastern coffee-growing districts in Minas Gerais, just as the city of São Paulo does those adjoining São Paulo State in the west and south-west.

North-eastwards from Rio de Janeiro State coffee-cultivation extends into the southern part of Espírito Santo, where coffee is an important and almost the only crop. The industry there is centred in the valley of the Itapemirim River, which is navigable from the port of the same name at the mouth as far as Cocheiro, where it is crossed by the Leopoldina Railway from Rio to Vitória. This district, it should be noted, is in almost the same latitude as the great one just north of Ribeirão Preto in São Paulo. Beyond Vitória, however, coffee disappears with the increasing temperature; the humid lowlands are better suited to cacao and the drier uplands to cotton.

The coffee plant is very exacting as to climate. It cannot stand frost nor fierce dry heat. It is sensitive to drought, but is injured by excessive rain. Thus there is a marked correlation between the amount and the seasonal distribution of rainfall, cloudiness and temperature on the one hand, and the location of coffee plantations on the other. North of the parallel of 20° S. favourable climatic conditions are not encountered again in South America except in a limited area situated between 8 and 12 degrees north of the Equator in the north-western angle of the continent; there the mistiness associated with a distinct summer rainfall, combined with the elevation on mountain slopes in the tropics, once more provides the necessary climatic conditions. Almost all the coffee produced in South America is grown at elevations of 1,200 to 6,000 feet, and the best qualities between 2,500 and 6,000 feet.

In view of the fact that fertilizers are not used on the coffee plantations of Brazil, it is appropriate to inquire whether there is any likelihood of the reserves of fertile and at the same time suitably situated land becoming exhausted there. Hitherto, the single crop system with its attendant insecurity has been the rule; but obviously the system cannot go on indefinitely, for there are more than 6 million acres under coffee in Brazil, and new areas of this size cannot be found every decade or so even in its ample coffee zone. Information is not available as to how long it takes land that has been exhausted by coffee to recuperate, but from experience gained in a general way, it is known that the crops obtained after burning off the second growth, mainly scrub,

are never so heavy as those from virgin soil. Sooner or later Brazilian coffee-growers will be forced either to use fertilizers or to introduce other crops by way of rotation. The second of these is more likely, and has, in fact, already been started in São Paulo, and this leads to a discussion of other crops than coffee in the region in question.

Sugar-cane has been cultivated for a long time in the lower Paraíba Valley in Rio de Janeiro, but the crop has recently made steady advances not only in the middle and upper parts of that valley, but also in the plateau districts of São Paulo and Minas Gerais, where it is found to thrive in succession to coffee. Most of the sugar produced in Brazil is grown after a primitive fashion with a minimum of cultivation, but the careful preparation and weeding of the ground necessary for coffee provides conditions for the succeeding sugar crop that gives it a special advantage. The three states São Paulo, Minas Gerais, and Rio de Janeiro now produce 45 to 50 per cent. of the whole Brazilian output. Pernambuco, for centuries the chief sugar-producing state of Brazil, has been surpassed by São Paulo, which has in its disused coffee lands a larger area of suitable climate and soil.

The need for supplying food materials for the relatively dense population of the coffee-growing districts of São Paulo has led to the extensive cultivation of three crops, namely maize, rice and beans, which form the staples of the workpeople. Each estate or fazenda constitutes a small self-sufficing unit, on which the labourers are commonly granted parcels of land to grow crops for their own use. In addition to what is grown in this way, however, large quantities of the three products mentioned are raised as field crops by the fazendeiros themselves.

With regard to maize, Brazil is apparently second among the producing countries of the world, being exceeded only by the United States; its crop averaging over 7 million tons in 1954-55 was more than twice as large as Argentina's. The greater part of this Brazilian maize is grown in a relatively narrow populous belt along the east coast from the 20th parallel southwards, mainly in Rio Grande do Sul, and the central group of states, among which São Paulo leads. Since, however, almost the whole of the crop is consumed within the country, if not in the districts in which it is grown, the quantities exported are negligible.

A black variety of bean is a most important article of food on the coffee plantations and among the populations of the coastal districts. This crop is grown extensively in São Paulo and is even planted between the rows of coffee plants. During the period of the first Great War an enormous expansion took place in the export of beans from this state and from Rio Grande do

Sul. Exports have since reverted to small proportions, but the crop remains an important one.

The third important food crop in the region, namely rice, has expanded even more remarkably. Rice is grown in the southern part of São Paulo, especially in the Iguapé district and also in that part of the Paraíba Valley which is within the state. At the height of the coffee fever from 1900 to 1907 rice was imported into São Paulo, but by 1914 the home demand was met. By 1920 there were considerable net exports, but since then domestic consumption has caught up with increased production.

The cultivation of cotton has also advanced rapidly in São Paulo in recent years. The annual variety, known as upland, succeeds almost everywhere in the state, the fibre being short, but of good quality. The most important district is one lying just west of São Paulo city, but cultivation has been spreading both farther west and towards the north along the lines of railway into the coffee districts. By 1919 São Paulo became the leading cotton-producing state in Brazil, furnishing about a quarter of the country's output. Cotton cultivation has expanded rapidly in that state which now produces more than half of the total for Brazil of some 400,000 tons. The short-staple upland type grown in São Paulo is consumed in large quantities in the cotton mills in São Paulo city, Rio de Janeiro, Juiz de Fôra, and Rio Grande, leaving, however, a considerable export surplus in recent years, in addition to that of the longer-staple sertão product from the North-East.

Stock-rearing was the most important industry in the early days of frontier settlement in São Paulo and it still retains a place of note. Each coffee fazenda of course keeps its herd of cattle for cultivation purposes, but of the total of 9 million cattle in the state many are reared in the pastoral region beyond the coffee zone in the west. Here, under conditions suited to European strains, a specialized form of stock-rearing, detached from agriculture, is coming into prominence. The industry, as usual in such regions, is worked in large estates, and centres on such railway townships as Barretos, São Manoel and Campos Novos. In connection with the cattle industry of São Paulo, mention has to be made of the important transit and fattening business carried on in respect of the animals brought in from Mato Grosso after being collected at Uberaba in Western Minas Gerais and at other points. With the growth of railways and with the reduction in the area of unfenced land this trade is declining in the intermediate districts; the animals tend more and more to be railed through to the neighbourhood of São Paulo City and there fattened by intensive methods, prior to slaughter either for the domestic meat

trade or for export as refrigerated beef. Thus we have here in Brazil the beginnings of the same highly specialized methods of the disposal of live-stock that have become so marked in a similar geographical region in the United States. In each region there is a great area of natural pastures to the west, a rich agricultural zone in the middle, and in the east a populous belt containing great cities that communicate readily with the outside world.

One of the manufacturing industries that has become established both in the neighbourhood of São Paulo City and in Santos is that of handling cattle in freezing works. The exports of beef from Brazil which were nil in 1913 averaged 74,000 tons for the four years 1928-31, but declined to 22,000 tons in 1948-49 and to 4,500 tons in 1955, owing to increased domestic consumption.

Textile and leather manufacturing industries had been established in such cities as São Paulo and Rio de Janeiro before 1914, under the stimulus of high protection, but the first Great War gave them their opportunity to supply the domestic market more or less completely. The number of cotton spindles in Brazil rose from 735,000 in 1905 to 2.7 million in 1929, of which about a quarter were in each of the cities above mentioned. By the late 1930's the Brazilian production of cotton, woollen, jute and silk goods and of footwear was sufficient to meet domestic requirements. During the second Great War further expansion, especially in textiles, enabled Brazil to become a large exporter of cotton goods to other Latin-American countries. Abundant local raw materials and cheap water power are the main advantages favouring the growth of these manufactures. São Paulo utilizes the falls on the Tieté as well as the head from a large dam on a coastal river, Rio the falls on the Paraíba.

One manufacturing industry in Eastern São Paulo deserves mention. Attempts have been made time and again to develop the iron industry, but without success, in spite of abundant local supplies of ores. Two difficulties stand in the way: one is the lack of good fuel other than wood charcoal, which is very expensive; and the other is the high rates of wages that have to be paid. Water-power has been applied with remarkable success in the textile and leather industries, but it is doubtful whether the electrical process is suitable for the production of pig iron; and cheap labour is not likely to be obtainable in a country where there appears to be a permanent shortage of workers.

The main features of the transportation system in this coffee-growing region have been touched upon above. With regard to the two great ports, however, it is interesting to note that while both can claim to be the leading gateway of Brazil, Rio de Janeiro

is so only in the import trade ; owing to the high value of the coffee crop Santos stands easily first in the export trade. From the centre of Brazilian life and commerce represented by the constellation Rio de Janeiro, São Paulo and Santos, it is natural that railways should extend, or be in course of construction, to the outlying parts of the country. Thus the Goiás Railway, some 220 miles in length, links Southern Goiás via Uberaba with the northern São Paulo system ; the Porto Esperança line, starting from Bauru north-west of São Paulo, and following the ridge south of the Tieté, meets that river near Itapura and then turns to cross the Paraná below the Urubupunga Falls, after which it traverses the wilds of Southern Mato Grosso right on to the Paraguay River—a total distance of nearly 800 miles ; the São Paulo-Rio Grande Railway, a still longer system nearly 1,200 miles in length, pushes south-westwards to the borders of Rio Grande do Sul.

The region surveyed in this chapter, together with that of Southern Minas Gerais, is without doubt one of the richest in the world from the standpoint of natural resources and productive capacity. Much wealth has already been extracted from it, but when its agriculture is developed on scientific and intensive lines, when its untapped mineral deposits are made available, when the abundant water-power is more widely developed in the service of manufactures, there will be few areas in the world of equal size that can rival it in material prosperity.

NOTE ON LATER DEVELOPMENTS IN THE COFFEE INDUSTRY

Though Brazil has the largest area of lands physically suited for the cultivation of coffee of all countries, it is losing in production relatively to those which are able to supply superior qualities. Since the pre-war years of heedless over-production, the national policy has aimed at restricting output to the quantities of Brazilian coffee the world market will absorb at reasonable prices. In the result, production has fallen 25 per cent since 1937-38, and cultivation has shifted selectively on to new lands. In the main central region, the westward movement has continued, as falling yields caused older plantations to be abandoned. Cultivation has been pushed beyond the Tropic of Capricorn, in spite of the risk of night frosts, into northern Paraná (see Table, p. 129), and is extending towards the Rio Grande in northern São Paulo. The limits of the main continuous area may have been almost reached, for since 1945 plantations have been established well beyond it round Goiânia in Goiás, and since 1950 still farther afield round Cuiabá in Mato Grosso. Corresponding to this general shift of coffee cultivation outward from the central core, there has been some redistribution of exports by ports, in which Santos has lost to Paranaguá ; of the total 16·8 million sacks exported in 1956, the approximate percentage shares of the four leading ports were : Santos 53, Rio de Janeiro 20, Paranaguá 18 and Vitória 6.

CHAPTER XIII

THE BRAZILIAN PLATEAU—SOUTHERN BRAZIL, PARAGUAY AND URUGUAY

FROM the southern borders of São Paulo and Mato Grosso the upland mass belonging to the Brazilian Plateau begins to narrow sensibly ; in latitude 25° S., between Asunción and Paranaguá, it is still some 600 miles wide, but beyond $27\frac{1}{2}^{\circ}$ S. it is traceable west of the Uruguay River only in the hills of Northern Corrientes ; and in Uruguay it narrows down to an average width of less than 200 miles. In this southern section the boundary of the plateau towards the interior lies roughly along a line drawn through a point just east of Asunción to Colonia on the La Plata Estuary, while the eastern boundary is a scarp edge following the Atlantic coast at a distance from it of not more than 50 miles as far south as the Lagoa dos Patos ; thence southwards this boundary is an ill-defined line that retreats gradually inland from the Atlantic till it meets the Rio de la Plata near Monte Video. The three southern states of Brazil, together with Eastern Paraguay, the Misiones Territory of Argentina, North-Eastern Corrientes and Uruguay thus physically form a single geographical unit, and the region, in spite of its various political subdivisions, can be conveniently treated as such.

The relief of this area is on the whole more complicated than that of the broader parts of the Brazilian Plateau. The main eastern divide which enters it from São Paulo continues through the states of Paraná and Santa Catarina, causing short streams to descend to the Atlantic and sending longer ones to the Paraná and Uruguay Rivers. Away to the west, however, in Paraguay, there is another divide between the Paraná and Paraguay Rivers. South of the Iguassú River a tongue of the plateau from Santa Catherina enters the Misiones Territory and continues south-westwards to form a parting between the Paraná and the Uruguay Rivers. Where the eastern edge of the plateau breaks down in the state of Rio Grande do Sul the main divide has been carried westwards so as to lie nearer to the Uruguay River than to the Atlantic, and considerable rivers, such as the

Jacuihy, drain into the Patos Lagoon. In Uruguay, however, the axis of the plateau called the Cuchilla Grande trends again eastwards and throws the major streams, such as the Rio Negro and its tributary the Yi, away from the Atlantic.

The general average height of the uplands in this whole southern area is less than in Central and Northern Brazil. While there are considerable sections in the eastern and central parts of Paraná and Santa Catarina which rise to some 4,000 feet above the sea, the hills in Paraguay are generally not more than 1,500 feet high, and very little of the uplands in Rio Grande do Sul and Uruguay is more than 1,000 feet in elevation. Only some 100,000 square miles, mainly in Paraná, Santa Catarina and Misiones, out of a total area in the region of about 400,000 square miles can be classed as real plateau or mountain country.

Geologically, the region represents a continuation of the formations found in the main plateau to the north. The axial system from the border of São Paulo to Southern Uruguay consists of a broad belt of crystalline and other ancient rocks such as gneisses, schists and slates, with occasional beds of limestones or marbles and frequent intrusions of granite and similar rocks. The central belt is bordered on either side, especially towards the west, by more or less undisturbed sedimentary strata, such as sandstones, shales and marl slates, which overlie the ancient series. In these there is an outcrop of a Permian formation containing coal along a line parallel with and east of the main axis running through Paraná and Santa Catharina into Rio Grande do Sul. In the latter state, however, and in Northern Uruguay much of the surface rock is archæan, the sedimentary belts on the eastern and western margins being narrow.

Towards the Paraná River in the western districts of Paraná State and in Misiones red soils similar to those in São Paulo are common, formed, as in that state, from decayed diabasic eruptive rocks. In the same region more recent basalts occur here and there and form ledges, as noted in Chapter IX, over which the rivers plunge in rapids and falls. The rolling country of Eastern Paraguay consists largely of igneous formations in which intrusive granite is a common feature.

Within the region as a whole the proportion of the surface covered with alluvial and similar soils is thus comparatively small. Along the east coast there is a narrow plain composed of river-borne material in the states of Paraná and Santa Catharina; unfortunately the drainage is poor and much of the land swampy and difficult to utilize. South of the Tuberão River in the southern part of Santa Catharina begins a series of lagoons along the shore which continues into Rio Grande do Sul,

and attains its greatest development in that state in the brackish Patos Lagoon. Farther south, however, extending beyond the frontier into Uruguay, is Lagoa Mirim, separated from the sea by a large sandy peninsula down the middle of which runs the elongated Mangueira Lagoon, entirely in Brazilian territory. The peninsulas that lie between the sea and these lagoons in Rio Grande do Sul are not of much use owing to the nature of the materials of which they are composed, but away from the lagoons inland there are considerable areas of lowland in the river valleys, parts of which are of great fertility. Next to the coffee-growing region, this comprises one of the agriculturally most productive regions of Eastern Brazil.

The lagoon formation associated with marshy tracts and sandy soils continues along the short south-eastern coast of Uruguay and renders the strip adjacent to the Atlantic one of the least productive in the little republic; but west of the main axis in Uruguay there are considerable areas of rich soils of somewhat similar origin to those of the Pampa—partly alluvial and partly wind-borne and rich in humus from the decay of grasses through thousands of years. Along the banks of the Uruguay River in Rio Grande do Sul there are some alluvial tracts, but as a rule the highland ridges advance close to the left bank of the river. North-Eastern Corrientes consists of a series of huge esteros or semi-permanent lakes with intervening ridges, and contains very little alluvial soil which is fit for agriculture or indeed for stock-rearing except in the dry season. The same features reappear in Paraguay both in the south along the course of the Paraná and again towards the west along the left bank of the Paraguay River. These swampy tracts in Corrientes and in Paraguay represent, in fact, an eastern outlying part of the Chaco region, where heavy summer rains falling on a flat, ill-drained surface give rise to widespread swamps and seasonal lakes, which often disappear completely during the dry winter season.

Throughout the region lying to the east of the Paraná, however, droughts are, on the whole, rare and of short duration. From the map (Fig. 5) it will be seen that the isohyets run in curves from N.W. to S.E., and that practically the whole area has a rainfall of 40 inches or more per annum. While there is little difference in the mean annual rainfall between the coastal districts and those in the interior in the same latitude, there is a great difference in the seasonal distribution; whereas in Southern Brazil rain occurs at all four seasons without marked differentiation, in Paraguay upwards of two-thirds of the rainfall comes during the summer months. There is a steady decline in the total rainfall from Paraná State to Uruguay, and in the

southern part of the latter country the climate is at times distinctly dry.

The causes that account for the rainfall of this transition area are somewhat complicated. During the summer a pronounced low-pressure area is established over Northern and North-Western Argentina, which gives rise to a strong north-east wind together with a northerly indraught of warm, moist air from Central Brazil. This causes the heavy summer rainfall in Paraguay and in the middle part of the Paraná Basin generally; but the coastal districts to the east are both too far removed from the continental low-pressure system and too much in the lee of the plateau to benefit from this source of rainfall; their summer rains are brought directly from the sea by the prevalent N.E. winds. During the southern winter, on the other hand, a dry föhn-like wind blows from the Brazilian Plateau into Paraguay and North-Western Argentina, and the distribution of pressure is sufficiently stable to prevent the intrusion of disturbances that might bring rain. Only when, with the return to southern spring, the continental high-pressure system breaks up, does the belt of frequent rains extend from the Equator towards Southern Brazil.

These general climatic features do not account by any means for the fairly regular distribution of rainfall throughout the year in Southern Brazil, Uruguay and Eastern Argentina. Cyclonic disturbances arising in two different ways give rise to summer rains, often heavy, in these regions; small areas of low pressure may become detached from the main one and move east or north-east, thus deflecting the normal N.E. air current and causing the formation of clockwise spirals; or cyclones may be developed in the tropical interior, and after moving S.W. towards the trade wind margin, then turn S.-S.E. into the Atlantic in the neighbourhood of the La Plata Estuary. Anti-cyclones moving from west to east often give rise to winter rains in the belt between 30° and 40° S., that is, on the margin of the zone of westerly winds. These anti-cyclones do not actually bring rain, but by moving under masses of relatively warm and humid air may cause them to part with moisture in the form of showers on being lifted.

In the northern part of the region, i.e. in the states of Paraná and Santa Catarina and in Paraguay, therefore, the rainfall shows distinctly the features of that common to the outer tropical belts; and the curve of the isohyets, concave towards the north-east, is an indication of the way in which the tropical influence is pushed into the interior during the summer. The lower rainfall towards the south follows from the fact that it

is caused mainly by irregular disturbances in a thoroughly transitional zone, a feature which accounts further for its fluctuations from year to year.

The general distribution of the natural vegetation shows a marked correspondence with that of the rainfall. Forests of various types originally covered most of the well-watered region north of a line drawn from Porto Alegre to Formosa town on the Paraguay, while south of that line, where the rainfall is smaller and less certain, grasses are the rule. Within the forested area, campos or natural grasslands covered the higher eastern parts of the plateau as well as detached upland districts farther west in both Paraná and Rio Grande. It would appear that the lower temperature and greater exposure on these heights, and probably also the absence of a soil retentive of moisture, are unfavourable to forest growth, and that farther south the climate is too severe except in a few places even at the lowest elevations for this type of vegetation. Of all South American countries Uruguay has the lowest percentage of forest area—less than $2\frac{1}{2}$ per cent, and such as they are, the forests there consist largely of strips along the streams with larger patches in the hilly country to the north.

Between the Atlantic and the Paraguay River three zones of forest running north and south are to be distinguished. The first is the tropical and sub-tropical forest along the coastal lowlands and up the eastern slopes of the plateau. This is simply a continuation of the Atlantic coastal forests of Central Brazil, and contains similar kinds of trees, mainly hardwood species. A second and broad zone of forest extends from the line along which the plateau begins to fall off towards the interior to within about 50 miles of the Paraná River. This is the famous Araucaria forest which reaches north into São Paulo as already mentioned, and which continues south beyond the upper Uruguay into Rio Grande do Sul. The total area covered by the Araucaria forest is about 300,000 square miles, but that of commercially valuable pine is probably only about half this figure. The best stands occur in the state of Paraná, and in consequence the tree is often called the Paraná pine. North and south of the central section of more or less pure Araucaria forests lie transition areas: towards the north in São Paulo the luxuriant mixed forests described on p. 146 above; and towards the south, in the Misiones Territory, another but less luxuriant type of mixed forest, in which the maté-producing tree, *Ilex paraguayensis*, is common; in Rio Grande do Sul, an opener kind with scattered Araucarias, giving place gradually to grasslands pure and simple.

A third zone of forests extends from the eastern edge of the low-lying valley of the Paraná westwards to the banks of the Paraguay. These are of the dense tropical evergreen type, containing a great variety of species, most of which have hard, heavy wood. Some of the trees, however, such as Spanish cedar, have softer and lighter woods useful for general purposes and of considerable economic value. As usual in forests of this kind, single species seldom occur in large numbers in small areas, nevertheless considerable quantities of timbers are cut both for local use and for the export trade to the markets in the River Plate region. These interior forests become rapidly lighter from east to west; along the banks of the Paraná practically the whole land surface is covered with dense forests, but the proportion of the area under forest falls to about 60 per cent between 56° and 57° W. and to no more than 25 per cent west of the 57th meridian. In the forests east of 57½° W. the small tree *Ilex paraguayensis* is of common occurrence and gives rise to an important industry in the collection of leaves.

In accordance with the varied natural resources of the great southern tongue of the Brazilian Plateau, its industries are more diversified than in many other parts of South America. Stock-rearing is perhaps the most important, but agriculture occupies a very important place. The extensive forest wealth gives rise to considerable timber-cutting in addition to the gathering of maté, and minerals are by no means neglected; while the preparation of maté, of salted and dried beef, and of frozen beef and mutton, forms the basis of large-scale factory industries.

The vast areas of natural pastures in Rio Grande do Sul and in Uruguay, together with the considerable areas of artificial pastures laid down where the forest has been cleared elsewhere, support great numbers of both cattle and sheep. The relatively cool climate of southern parts, combined with the more or less even distribution of the rainfall throughout the year, is favourable to the stock-rearing industry which is carried on after the Argentine fashion by campo barons in Rio Grande do Sul and by large estancieros in Uruguay. The active demand for superior types of animals for the frozen meat trade has led to the importation, especially into Uruguay, of improved strains of both sheep and cattle, which there find a congenial environment. Neither in Rio Grande do Sul nor in Uruguay, unfortunately, are the subsoil conditions favourable for lucerne, widely cultivated in Argentina as a fattening fodder. Thus these two areas have to rely almost exclusively upon pastures, much of which, except in Southern Uruguay, are of the coarse kind called *pasto duro*. The table below shows the number in millions of each of the two

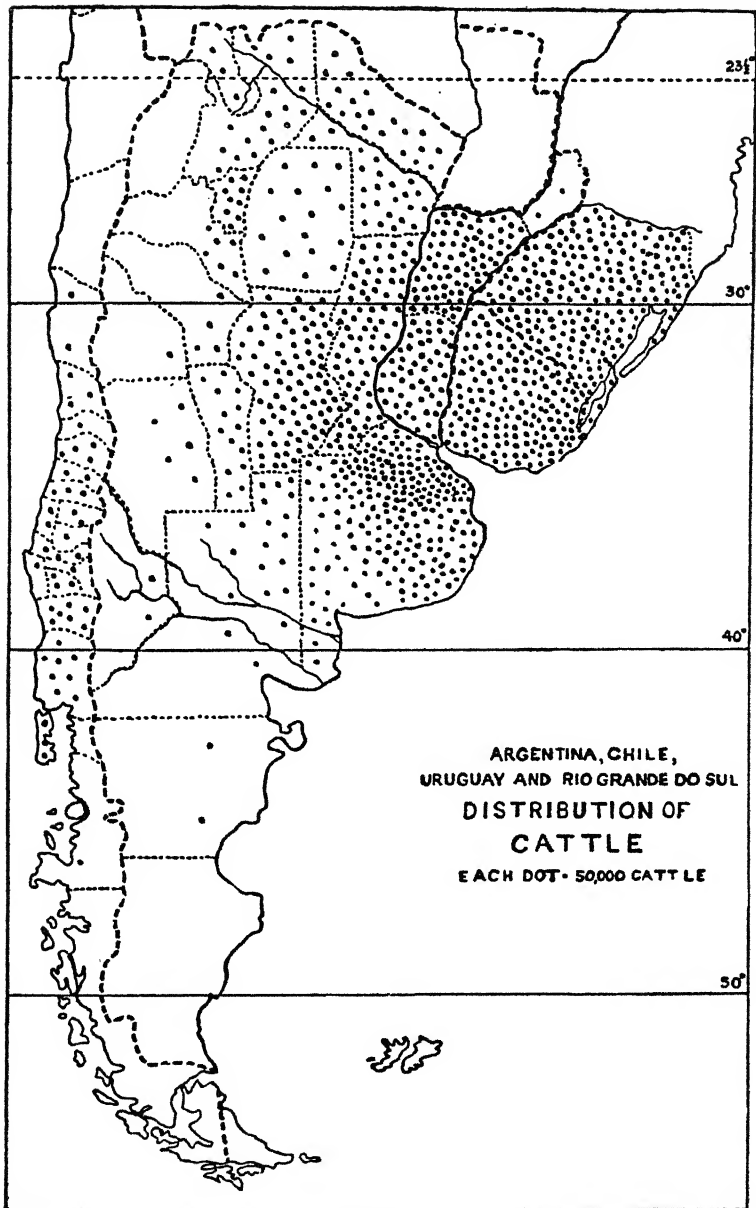


FIG. 24.—Distribution of Cattle.

main classes of live-stock in the various political divisions of the region under discussion.

	Cattle	Sheep
Uruguay (estimate 1956)	8.15	23.41
Rio Grande do Sul (estimate Dec. 1955)	9.17	11.4
Totals of above	17.32	34.8
Paraná and Santa Catarina (estimate Dec. 1955)	2.74	.33
Paraguay (estimate Dec. 1955)	4.0	.22

Two facts become apparent from these figures—first, the relatively large number of both sheep and cattle in the region as a whole; and second, the exceedingly high proportion of animals in the two southern divisions, namely, Rio Grande do Sul and Uruguay. The single state of Rio Grande do Sul contains, in fact, about one-seventh of all the cattle in Brazil and upwards of two-thirds of all the sheep.

Freezing works have been in existence in Montevideo for a long time, and they now handle most of the surplus live-stock reared in Eastern and Southern Uruguay; but large numbers of inferior cattle, particularly from the west, are still sent to the *saladeros*¹ and meat extract factories along the Uruguay River. In Rio Grande do Sul most of the surplus cattle were utilized till recently for the manufacture of salted and dried beef, which found markets all the way up the Brazilian coast, and even in the West Indies. This business has, however, declined very much since the construction by Chicago magnates of two freezing works at the Atlantic ports of the state. As time goes on, it is likely that stock-owners in Rio Grande do Sul will aim more and more at rearing a class of animals suitable for the “*frigoríficos*,” which offer higher prices than do the *xarqueadas*. The freezing works, moreover, provide an outlet for sheep which was formerly absent, and their existence is accordingly likely to stimulate sheep-farming, an industry that has hitherto never made much progress even in Southern Brazil.

The number of cattle in Uruguay is somewhat smaller than that in Rio Grande do Sul; but the export of beef from the former is much greater, and grew rapidly in the period 1910–32, though it has since declined with the movement towards diversification of industry (see p. 169).² Since live-stock figures did not increase in the same proportion in the same period, the conclusion

¹ The works in which dried and salted beef are prepared (*xarque* in Portuguese, *tasajo* in Spanish) are called *xarqueadas* in Brazil and *saladeros* in the River Plate.

² Uruguayan exports of meat and meat products in tons: 90,000 (1910); 144,300 (av. 1929–32); 100,600 (1938); 94,000 (1949).

is that the rate of turnover was accelerated. Thus the actual numbers of animals form no true basis of comparison for productive purposes even in the same country at different times, and still less between one country and another. The probability is that the 9 million cattle in Rio Grande do Sul produce much less beef than that obtained from a smaller number in Uruguay, which possesses the great advantage of having large areas of succulent pastures. Nevertheless, Brazil changed from a meat-importing country in the period prior to the first Great War to a meat-exporting country after 1915. Whereas the excess of imports of meat of all kinds into Brazil amounted to about 35,000 tons in 1910, the average net exports for the three years ending 1939 were over 230,000 tons. To this advance two areas in particular contributed, namely, São Paulo with the adjoining states in Eastern Brazil, and Rio Grande do Sul. The generally mediocre cattle of Brazil are, however, not really suitable for the export trade in frozen beef, which has dwindled since 1939 and may disappear (see p. 153).

Stock-rearing is of secondary importance in Paraná and Santa Catarina, where the industry has not yet come into touch with modern developments. In Eastern Paraguay, although it is one of the leading industries, it is still in a backward condition. The sub-tropical and tropical lowlands of that country do not appear to be well suited to cattle, and still less to sheep. Both classes of animals are of a very indifferent quality, and are liable to be attacked by various diseases. Attempts were made a few years ago to start freezing works in Paraguay, one near Asunción and another to the north, but both have since been closed. The surplus animals are hardly fit for the frozen meat trade, and will now be sent, as they were before, either to the local salt beef and meat extract factories or down the Paraná to the great markets for such classes of stock on the lower Uruguay.

Brazil is one of the most important pig-rearing countries of the world. According to official estimate there were in 1956 over 38 million pigs in the country, 30 per cent. of which were in the three southern states, and 5 million in Rio Grande do Sul alone. As in the United States, maize is widely used in Brazil as feed and fattening material for the pigs kept, and there is accordingly the same tendency to specialize in the lard-producing type. In spite of the great number of pigs in Brazil, very little pig-meat is available for export. Large quantities of lard were, it is true, sent to Europe from 1918 to 1921, but this trade has since declined to quite small proportions.

The cultivation of crops is a most important industry in Southern Uruguay, in the more settled parts of Paraguay, and in

various parts of Southern Brazil, especially Rio Grande do Sul. Maize is the leading cereal everywhere except in Uruguay, where wheat is grown in preference to fodder crops on the limited arable land. The importance of Southern Brazil in the production of maize is indicated by the fact that the average annual crop there amounts to upwards of half of that from the whole country.

Among the other cereals, rice is widely cultivated on the coastal lowlands of the three southern Brazilian states, especially on the wide river plains that open on the Patos Lagoon in Rio Grande do Sul. The quantities of rice grown in Brazil have expanded enormously since the early years of the present century, and now amount to upwards of 4 million tons per annum; after 1926, there was a surplus for export, amounting in 1939 to 59,000 tons, and in 1948 to 213,000 tons, arising from expansion of cultivation, mainly in Rio Grande do Sul and São Paulo. Subsequently, however, domestic consumption increased rapidly, and in the years 1953-55 exports were negligible. The expansion in the cultivation of rice has been paralleled by an increase in that of beans, with Rio Grande do Sul as the leading state. Both rice and beans are staple foods of the fast-growing population.

In a country such as Brazil, in which the staple foods are such tropical and warm temperate crops as mandioca, rice, maize and beans, it is natural that wheat-growing should occupy a minor place. In point of fact, very little of the country is climatically suited to wheat, owing to the general warmth and the prevalence of heavy summer rains. Rio Grande do Sul is perhaps the only state in which the crop can be grown with success, and it is consequently not surprising that this one state accounts for over 80 per cent. of the entire but small Brazilian production, a quantity insufficient to the very limited demand of the country. In Southern Uruguay the climate and the soil are both favourable to wheat and to linseed, as they are in the Argentine territory across the estuary. Though Uruguay is primarily a stock-rearing area—in fact, one of the most exclusively stock-rearing countries in the world—more than sufficient wheat is usually grown to supply the needs of the country, which, in contrast with Brazil, looks to that cereal as its main breadstuff.

In addition to the crops just mentioned, very large quantities of fruit, in particular of bananas, grapes and oranges, are produced in one district or another of Southern Brazil and Paraguay, and find markets in Buenos Aires, Montevideo and Rio de Janeiro. Rio Grande do Sul is once more an important producer, especially of grapes, while Paraguay exports annually large quantities of oranges. Another crop to which large areas are

devoted in both Rio Grande do Sul and Paraguay is tobacco. About a quarter of the total acreage planted to that crop in Brazil is in the southern state, which is second only to Bahia in this branch of agriculture.

The above survey of farming industries in the whole region serves to emphasize the outstanding importance of Rio Grande do Sul in agriculture as well as in stock-rearing, not only amongst its neighbours, but also amongst all the states of Brazil with the exception perhaps of São Paulo. In many ways it deserves the name of the granary of Brazil. A plantation industry has, however, recently developed in Southern Brazil, in which Rio Grande do Sul has no share. Maté has for a long time been collected from the trees growing wild in the forests in the middle Paraná basin, but by now large plantations of this tree have been established in Paraná and Santa Caterina, in Paraguay and in Misiones, from which an ever-increasing proportion of the product is obtained. In Paraguay, for example, it is said only 500 tons of maté came from plantations in 1915, while three years later nearly 3,500 tons came from that source; and still greater progress has been made with plantations on the western edge of the Araucaria forest in Brazil, which in 1955 produced 60,000 tons of maté.

The collection of maté leaves from wild trees, together with the preparation of the raw leaf for the market, has for many years past been a leading industry in South-Eastern Paraguay, Western Paraná, and the Argentine Territory of Misiones. Maté, so named after the gourd out of which the Indians were accustomed to drink what is otherwise known as Paraguay tea, is the regular beverage of the people almost everywhere south of the 25th parallel in South America, just as coffee is of those north of it. The market for the product is thus sufficiently large, since maté is consumed by some 25 millions of people in South America, and these the more prosperous, to say nothing of numbers in Spain and Portugal who have learned to like maté through residence in, or connection with, South America. The collection of wild maté has on the whole been a flourishing industry, though crises have occurred from time to time through over-production; however, the recent rise of the plantation industry must tend to render the forest industry less profitable.

Partly owing, it may be, to the risk of over-production, and partly no doubt also to the necessity for treating the leaves in factories, the whole maté industry tends to get into the hands of a few large firms whose headquarters are in such towns as Curitiba and Asunción. The work of collecting maté is confined to the six months of the year during which the leaves are suitable,

and much of the product that reaches the factories is despatched by groups of collectors who work over certain parts of the forest and dry the leaves as they proceed. The wild maté industry is free from the main disability attending most other industries in the interior regions of South America: the dried product is light, and when properly packed not bulky in proportion to weight and value, so that it will stand transportation over considerable distances on mule-back.

The three countries which produce maté all consume it extensively, but two of them, Brazil and Paraguay, have a surplus for export. In 1955 Brazil supplied over 52,000 tons to other countries, and Paraguay some 1,200 tons, almost all to Argentina, Chile and Uruguay. Argentina's domestic production is still much below its requirements, but plantations in Misiones and Corrientes are supplying increasing proportions of the annual consumption of about 150,000 tons, with a corresponding decline in imports, especially from Paraguay.

Protected by exceedingly heavy duties and stimulated by the restriction of imports from 1914 to 1918, the Paraná pine timber industry of Southern Brazil made rapid strides. Prior to 1914 Brazil imported about 80 million feet of timber per annum, mostly softwoods from the United States and Canada, but in normal post-war years the imports are not likely to amount to more than a quarter of that figure, if as much. The average exports in the six years 1925-30 of 122,000 tons rose to nearly 700,000 tons in 1950-51, of which the greater part was sent to Argentina. This marked change, so far as Brazil is concerned, from a timber-importing to a timber-exporting country has been due in large measure to the development of the Paraná pine industry, though not entirely so, because there has been a considerable increase recently in the exports of cedar. According to estimates, the Araucaria forests contain sufficient timber to supply for many years to come not only the domestic trade of Brazil, but also a considerable export trade to countries in South America that are deficient in softwoods. The great difficulty hitherto has been to supply the timber at competitive prices; as the industry advances the costs of cutting and of transportation should both diminish, but this will be possible only if the number of large mills is increased and the railways serving the forest areas are modernized and extended.

The region comprising Southern Brazil, Uruguay and Paraguay is relatively poor in mineral deposits. The archæan formations in Rio Grande do Sul contain the most important copper mines in Brazil, some 50 miles north of the Rio Grande-Bagé railway, while small quantities of gold are mined in the

Rivera Department in Uruguay. The north-western parts of the same country have long been famous for semi-precious stones such as amethyst, agate and chalcedony. The igneous formations in Eastern Paraguay are said to contain deposits of copper, lead and other metals, but these are not worked. Indeed, as far as can be judged, Paraguay is the poorest of South American countries in mineral deposits.

Of far greater interest than these minerals of igneous or metamorphic origin is the coal in the eastern sedimentary series from São Paulo to the Uruguayan frontier. This, the only coal in Brazil, occurs in the Rio Bonito beds of the Tuberão series which crop out in a band about 12 miles in width, in two stretches—first, from Itapetininga in São Paulo, approximately along the route of the Rio Grande railway via Boa Vista in Paraná, into Santa Catarina; and, second, in Rio Grande do Sul, from S. Jeronimo near Porto Alegre to Jaguarão close to Lake Mirim. Of these two series, that in Rio Grande do Sul has the advantage of convenient situation with regard to water transport, especially for the new steel mills at Volta Redonda, but the annual output from it is rather smaller than the million odd tons from the Santa Catarina deposits.

The Brazilian coal is of poor quality. It contains very high percentages of ash and sulphur,¹ is of low heating power, and is unsuitable for smelting purposes. Moreover, the seams are thin and the coal is difficult to handle, since it crumbles on exposure to the air. It is not, therefore, surprising that the domestic production of coal in Brazil is small, amounting to about 2 million tons a year. The inferior local product finds great difficulty, in short, in competing under normal conditions with foreign coal.

The trade of the whole region south of São Paulo and east of the Paraná-Uruguay line concentrates on three major ports, Paranaguá, Rio Grande and Montevideo, and two minor ones, São Francisco in Santa Catarina and Porto Alegre in Rio Grande do Sul. The trunk railway from São Paulo to Montevideo, which, like other lines in the eastern plateau region, follows more or less faithfully the crest of a main watershed, is connected with the four Atlantic coastal ports by important lines. The northernmost of these, running from Paranaguá via Curitiba to Ponta Grossa, follows a difficult route up the eastern scarp and was constructed at great cost. With its branch from Serrinha

¹ The average result of numerous analyses of Brazilian coal is as follows : Fixed carbon, 43 per cent. ; Sulphur, 5.5 per cent. ; Ash, 28 per cent. ; Water, 3.5 per cent. ; Volatile matter, 20 per cent. Calorie value, 4,500 to 6,000.

to São Francisco, it constitutes the only direct railway link between the coast and the plateau in the 700-mile stretch from Santos to Rio Grande.

Where the high eastern wall of the plateau breaks down in the Lake Patos region of Rio Grande do Sul, communication between the sea and the interior becomes much easier, not only because railway construction presents fewer problems, but also because three navigable rivers empty themselves into the great lagoon, one of which gives access to another large lagoon to the south. Two ports serve the region, Rio Grande near the entrance to, and Porto Alegre at the head of, the rather shallow lagoon; the former is an international port, the latter owing to its situation more local in character. The railways that link these ports with the trunk line well inland converge towards Cacequí, whence the Porto Alegre Railway continues right across the state to Uruguayana opposite Libres on the Argentine side of the river, and then turns south along the left bank of the Uruguay River until it meets the North-Western Railway at Cuareim. Between Santa Maria and Cacequí this railway forms part of the vertebral railway through Southern Brazil.

The railway system of Uruguay branches out radially from Montevideo. Here the relatively flat relief allows of the construction of lines in any desired direction. Much the most important line is the Central Uruguayan from Montevideo to the Brazilian frontier at Santa Anna do Livramento, with branches towards the Atlantic and towards the Uruguay River. The importance of this river as a means of communication is brought out by the fact that both the Uruguayan and the Argentine railways reach out to various points on its banks. Thus the other important railway in Uruguay, namely, the Midland, connects the districts on the lower course of the river as well as others on the shores of the La Plata Estuary with Montevideo; while on the Argentine side the main line northwards to Misiones and Paraguay follows the river closely for 250 miles north of Concordia.

The value of the Uruguay River as an inland highway is reduced by the rapids that occur just above Salto. Below this point such cattle-handling centres as Paysandú, Fray Bentos and Soriano are accessible from the sea, and there is an upper stretch of navigation from Salto to San Tomé. It is thought that the Paraná at one time crossed the estero region of North-Eastern Corrientes and then followed the course of the Uruguay. By changing its course to the present longer channel it falls more gently and provides navigation much farther into the interior. All the same, the Misiones district remains largely isolated except

for the single railway up the Uruguay Valley and on to Posadas. Neither the giant Paraná along the north-western edge of Misiones, nor the Uruguay running almost parallel on its south-eastern border, are of much service, owing to their rapids, in bringing the territory within easy reach of the busy centres on the La Plata Estuary.

At Posadas the Paraná is some 2 miles wide, and consequently there is no thought of bridging it. Trains are ferried across to Encarnación in Paraguay, whence a railway proceeds by way of Villa Rica to Asunción. That country as a whole is still very backward, its population almost pure Indian, and only the central southern part of it, namely, that traversed by the railway, is at all developed. With two main avenues of communication, one by river and the other by railway, Paraguay has recently, however, begun to feel the vigorous commercial influence of Buenos Aires, and may in the not distant future turn its undoubted resources to valuable account.

NOTE.—Since 1930 manufactures have developed both in Uruguay and in Southern Brazil, in the former chiefly at Montevideo and in the latter at Rio Grande and Porto Alegre; Rio Grande do Sul now produces upwards of 10 per cent. of the total Brazilian industrial output. In addition to the older meat and grain processing industries, a wide range of manufactures has been established in the above centres, in particular of textiles, metal goods and vehicles, chemicals and drugs, leather goods and cement. All three towns are centres of communications by sea as well as by land, enabling them to obtain local or imported fuel and raw materials, and to distribute the finished products coastwise and inland. This diversification of industries in what have hitherto been almost exclusively pastoral regions may develop further under nationalist economic policies and the reaction from extreme specialization in export industries.

CHAPTER XIV

THE ARGENTINE PAMPA AND THE MESOPOTAMIAN REGION

TO the people of Argentina the name Pampa denotes an area of about 250,000 square miles spread out like an open fan, with a radial distance of 350 to 400 miles from Buenos Aires. The straight edge of the semicircle so formed runs along the southern shore of the Rio de la Plata through the city of Buenos Aires, and continues till it meets the Paraná above the town of Santa Fé. From this point the landward edge of the Pampa sweeps in a curve south-westwards through Córdoba Province into S. Luis, and thence continues its circular course in the second quadrant until it reaches the coast slightly south of Bahía Blanca. The distinctive features of this area are first, its natural grass vegetation, and second, its almost uniform flatness. The landward limit above described is marked by the transition from grass to scrub or forest, and except on the eastern slopes of the ranges in Córdoba and on the sierras in South-Western Buenos Aires the contours never exceed 150 metres above the sea.

Climate, soil, relief, and the nature of the drainage all contribute to differentiate the Pampa from the adjoining regions.

The isohyets of total annual rainfall run in curves from north-west to south-east, and the western and south-western limits of the Pampa follow approximately that of 450 millimetres, or 17 $\frac{3}{4}$ inches of rain. Towards the north-west the grasslands are cut short by the forests that extend from tropical South America to their southern limit there. In such a large transitional climatic area as the Pampa distribution of rainfall according to the seasons naturally varies somewhat, but the Pampa as a whole is distinguished by the absence of the dry season characteristic of the lands beyond its border in the interior. The northern districts in Santa Fé and Córdoba share to some extent in the summer rainfall of the Chaco, and have therefore a summer maximum; the central and eastern parts of Buenos Aires Province have spring and summer maxima; and the south western border of the Pampa gets more rain in winter

than in any other season. The differences between the maxima and minima seasonal rainfalls are, however, nowhere very great on the Pampa. Proximity to the sea and exposure to prevailing winds from it cause the region to be favoured with a generally equable climate, warm temperate towards the north and cool temperate towards the south. Droughts sometimes occur, especially in the interior districts, and the day temperatures then rise to high figures, but generally there is an absence of oppressive heat in summer as well as of severe frosts in winter.

The soils of the Pampa consist as a rule of fine materials free from pebbles. Towards the interior they tend to be sandy, but near the Paraná they consist of rich black loams. Clayey soils are rare except in the eastern districts of Buenos Aires. The Pampa deposits reach to a great depth, and rest upon a sunken section of the Brazilian massif (Brasilia), which reappears in several disconnected inland ranges (see pp. 172-3). Maritime remains have been found near the Atlantic coast and along the banks of the Paraná, but marine sediments seem to be confined to these districts. The greater part of the Pampa soils have probably originated in the Andes, and been transported eastwards by rivers and by the winds. The rivers have deposited sands together with finer materials along their meandering courses, and the winds have sifted out this debris and transported the lighter material farther east till, with the increasing humidity towards the Paraná River and the sea, much even of the fine dust has become fixed. This accounts for the prevalence of sandy soils in the interior and of fine sandy loams towards the eastern districts. Natural agents have thus dowered the most accessible parts of the Pampa with the greatest wealth in soil fertility combined with the best climate in the whole of Argentina. Towards the south-west a limestone stratum, varying in thickness up to several yards and known as *tosca*, often rises close to the surface and is sometimes actually exposed, especially in south-east La Pampa Province. Wherever this peculiar formation occurs not far from the surface, the land is of little value either for pastures or for crops. The *tosca* has apparently been formed by concentration in the sub-soil layers of calcareous matter carried by percolating waters, which in the dry climate are unable to carry it away; subsequent deflation by the winds causes it to appear at or near the surface in places.

In relief the Pampa is peculiarly uniform. Its surface, except where it is crossed by the sierras mentioned above, rises so gently from the eastern margin that to the eye it generally appears uniformly level. In the drier western border, however, sand dunes are common, and dead dunes now covered by vege-

tation are found in Central Buenos Aires and elsewhere. The rivers of the Pampa seldom have defined valleys, and very few continue as live rivers all the way to the sea. Much of the drainage, in fact, proceeds eastwards under the surface and only becomes apparent in hollows occupied by seasonal lakes and marshes. This flowing underground water-table has given a value to the outlying districts which was not at first suspected, since the deep-rooted alfalfa or lucerne is able to reach this water in large areas that formerly supported only coarse grasses. Along the left bank of the Paraná, and again along the Atlantic coastal district, the drainage is apt to be incomplete and the surface soil to be waterlogged.

The Mesopotamian region, comprising the provinces of Entre Rios and Corrientes, differs in various essential features from the Pampa. Its rainfall is characterized by the spring maximum of Southern Brazil; its soils are mostly of direct fluvial origin rather than eolian origin, and are as a rule clayey in composition; its relief is more undulating and its drainage a more normal surface one, by means of streams which are well defined except in the northern part of Corrientes.

The whole plain, comprising the Pampa and the two eastern provinces, has been built up within comparatively recent geological times in a shallow sea that once extended inland beyond what is now the border of the Pampa. On the Atlantic shore of Buenos Aires Province, however, the plain does not fall gently to the sea, but rises from it in a series of low cliffs and old sand-dunes. Through these the coastal streams have in some places cut channels, but have failed to do so at others, and have thus given rise to the zone dotted with marshes and lagoons which has already been referred to. Along the lower Paraná, although much of the country is flat and liable to inundation, there are barrancas or bluffs at intervals, resembling the low cliffs along the seashore. These elevated strips, whether on the Paraná or along the estuary and the Atlantic, have been chosen as the sites for towns: Santa Fé, Rosario, Buenos Aires, La Plata, and Mar del Plata are all built on barrancas overlooking the river or the sea.

The sierras of Tandil and of Ventana in the southern part of Buenos Aires represent islands, as it were, of older formations rising from the floor of the plain that has advanced from the west and has completely surrounded them. They are composed for the most part of archæan rocks in which quartzite is prominent, but these rocks are overlaid in places by sedimentary strata of Devonian age. Structurally, these two "island" ranges seem to be related to the Pampa ranges to the north-west in S. Luis

and Córdoba. Like them, at all events, they consist of formations much older than those of the Andes ; they are probably re-elevated sections of the inner continental margin of Brasilia, which has subsided in the wide intervening Chaco-Pampa basin. The Tandil Sierra has an average height of about 750 feet, but rises to 1,400 feet near the town of Tandil; the Sierra de Ventana is higher, and reaches a maximum height of over 3,000 feet. Between the ranges, which both run north-west to south-east, lies a broad valley about 100 miles in width and about 140 miles long, the soils of which are generally either clayey or sandy, and are underlaid in places by *tosca*. Part of the drainage of the sierras works to the Atlantic by streams which, owing to their fairly rapid fall, usually have well-defined channels ; but some of it finds its way inland into saline lagoons both in the medial valley and towards the north-west. The region lying west and north-west of the Sierra de Ventana is, in fact, distinctly one in which evaporation is greater than the run-off, and has long been important as a source of salt (cf. p. 46).

With the other ranges to the north-west whose eastern slopes only are within the limits of the Pampa we are not here concerned, beyond observing that on these slopes the water-table is generally low, too low often even for lucerne, but that the soils are fertile and capable of producing cereal crops wherever the rainfall is sufficient. As the slopes of these sierras are exposed to the rain-bearing air-currents, and advance sufficiently far north in Córdoba to come under the influence of the Chaco low-pressure system in summer, they are of considerable agricultural importance. They constitute, in fact, the outer margin of the Argentine corn-lands so far as distance from Buenos Aires is concerned.

It has been remarked above that the Pampa rivers as a rule fail to continue in the ordinary way till they empty themselves into the sea or into other rivers. To this there are a few exceptions formed by rivers that are continuous, at all events at certain seasons. One is the Rio Salado of Buenos Aires, which originates in the north-western section of the province and reaches the sea by a very meandering course some distance south of the La Plata Estuary. Another and more striking of these seasonally complete rivers is the Rio Salado, or Juramento, which traverses the Chaco area diagonally before entering the Pampa in Santa Fé Province. This river derives its main supply of water from the mountains of Salta, in a region where there is a regular alternation of wet and dry seasons. As it proceeds across the plains, however, it loses volume, since evaporation and infiltration are both intense ; by the time it reaches Santa

Fé it is a small and uncertain stream quite unfit for navigation, though with slight rectifications it could be made navigable for a long distance higher up. A feature common to both the Jura-mento and the Salado of Buenos Aires, and indeed to all rivers that flow for a longer or shorter distance across the Pampa, is that they are liable to change their courses, and to fill their abandoned side-channels in the flood season with water which afterwards slowly evaporates or soaks away, and in course of time forms saline deposits or tracts of salt-impregnated land.

The Paraná itself is liable to periodic and sometimes to exceptional floods, and then spreads itself out in a huge irregular body of water many miles wide, covering the elongated islands normally above water between its various branches. Below Corrientes the principal branch of the river at mean water is from half a mile to one and a quarter miles wide, and is navigable for ocean-going vessels as far as Santa Fé. Since the Paraná carries an immense volume of water from the warm tropical interior of the continent, fogs are of common occurrence in its lower course and particularly over the estuary, where the warm water of the river meets the cooler air from the sea. Such a large river naturally carries great loads of sediment which, together with those brought down by the Uruguay, are deposited freely in the La Plata Estuary, and render the task of keeping deep-water channels open for shipping by no means easy.

On the left bank of the Paraná in Northern Corrientes there is a curious region characterized by fresh-water lagoons, of which the Laguna de Ibera is the largest. These, after being filled with water by the heavy rains, drain off slowly either into the Paraná or into the Uruguay, and thus constitute the reverse of overflow basins of these rivers. Like the middle Nile, they are covered in places with masses of floating vegetation or *embalsado*, which drifts about with the winds, while their margins are marked by extensive swamps. This region has recently been investigated by an Argentine scientist, who is of the opinion that the hollows occupied by the lagoons have been formed during a period of eolian excavation when the climate was much drier than now.

Though Argentina may continue to develop manufactures, its economy must always be based upon its great agricultural resources, and this holds with still greater force of the Pampa and Mesopotamian regions. The latter possesses no mineral deposits except the surface salt of the saline tracts; even building materials are scarce, and both lime and stone are brought in large quantities from other parts of Argentina or from Uruguay. Fuels—coal, petroleum and firewood—are all absent. There are

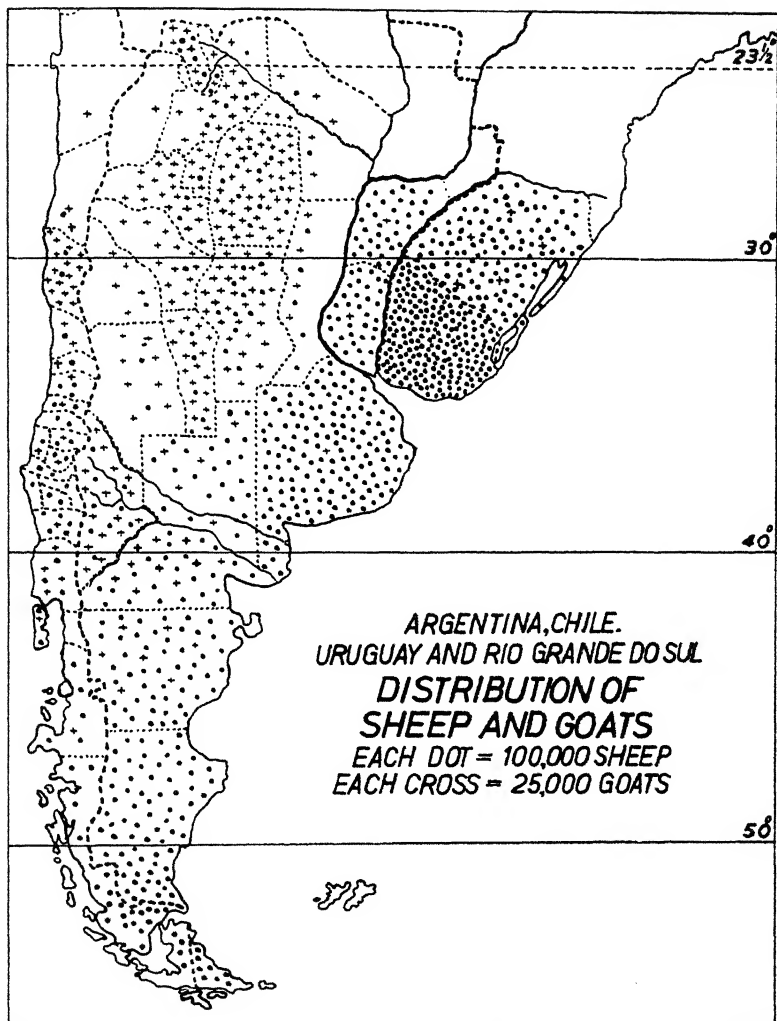


FIG. 25.—Distribution of Sheep and Goats.

no forests to supply timber, and no streams capable of furnishing water-power. But the productive capacity of the soil is enormous, and most of it can be turned to account with a minimum expenditure of capital and labour.

For centuries the Pampa was of little account because it could produce nothing that was much in demand in other parts of the world, or could be transported thither if it were. Its development was accordingly slow. Such industry as there was consisted exclusively of a form of stock-rearing much allied to hunting. Even when about the middle of the nineteenth century the European demand for pastoral products from the Pampa began to make itself felt, the rearing of animals there still retained its semi-nomadic features owing to the difficulty of enclosing the stock. It was only when the rising foreign demand began to make it worth while to employ improved strains and improved methods of stock-rearing that the transition to estancia economy took place. One great difficulty that stock-rearing on the Pampa has always had to face is that of securing sufficient supplies of water for the animals. There is a scarcity of surface-flowing water, as we have seen, and it has become necessary with the fencing in of the estates to sink wells to tap the underground supplies; but where these are saline, as in the southwestern districts and in Northern Santa Fé, the provision is not yet satisfactory.

The Pampa began to wake seriously from its long period of stagnation about 1870. The first form of the pastoral industry to become modernized was sheep-rearing. Wool, skins and tallow were sent abroad before the introduction of refrigerated transportation, and the surplus animals furnished meat for the *saladeros*. About 1880 frozen mutton began to be exported, and a couple of decades later the number of sheep on the Pampa reached its maximum. With the change from wool to mutton as the primary product of the industry, came a gradual substitution of Lincolns and crossbreds for Merinos.

Cattle-rearing remained unimportant as long as the only exportable product was hides, but the establishment of the frigorificos, or freezing works, revolutionized this branch of the pastoral industry by causing a great increase in the value of cattle suitable to the frozen meat trade. An enormous premium was thereby placed upon improved stock, and the native or *criollo* animals were rapidly graded up by means of the best meat-producing stock, such as Shorthorns and Herefords imported from Great Britain. Cattle-rearing on the Pampa received a further great stimulus through the spread of alfalfa cultivation from Córdoba. This crop is admirably suited to very extensive

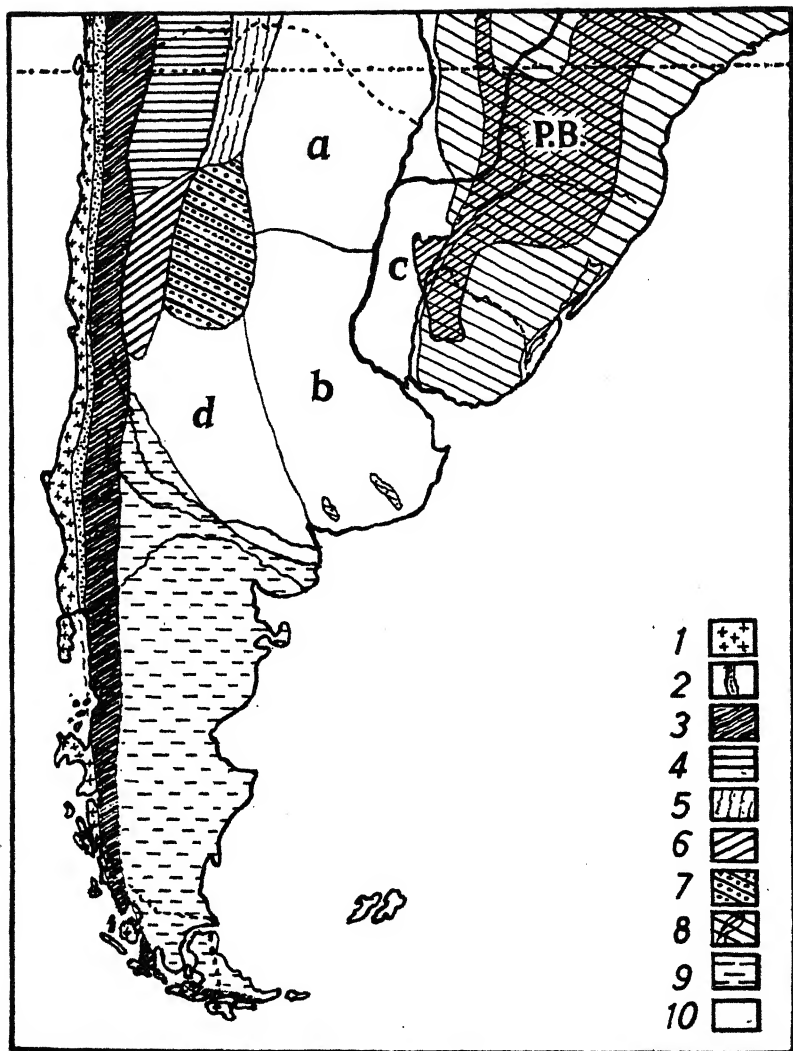


FIG. 26.—Structural Elements of Southern South America.

1. Coast Range. 2. Chilean Longitudinal Depression. 3. Folded Andes. 4. Puna. 5. Sub Andes. 6. Pre-Cordilleras. 7. Pampa Sierras. 8. Brazilian Massif, with area originally covered with Paraná basalt (P.B.). 9. Patagonian Plateau. 10. Interior Basin of Sedimentation: (a) Chaco; (b) Pampa; (c) Mesopotamia; (d) Monte.

areas on the plains, provides excellent fattening fodder for cattle, and occupied in the 1920's a third of all the cultivated land in Argentina. From less than a million acres in 1888, the area under lucerne rose to 13½ million acres in 1912 and to nearly 21 million acres in 1922. The extension of the lucerne pastures depressed sheep-rearing on the Pampa at the same time that it stimulated cattle-rearing, since sheep by their close grazing damage these pastures. Since 1945 the area under diversified crops and pastures has increased at the expense of that under cereals and linseed, accompanied by increases in the numbers of both cattle and sheep; thus with this redistribution has come some reversion to the earlier pastoral economy.¹

The pastoral industry remained the mainstay of economic life on the Pampa till the early years of the present century. Prior to 1900, however, the cultivation of wheat, maize and linseed had made steady progress, and by 1904 the value of the cereals exported from Argentina exceeded for the first time that of the combined exports of pastoral products. Almost all the grain produced in Argentina, and the whole of what is exported, is grown on the Pampa and in Entre Rios. In fact, the wheat-alfalfa rotation has tended to push sheep-rearing off the southern districts on to the drier lands beyond. Thus, while the Pampa was able to retain its supremacy in stock-rearing owing to the great increase of cattle reared on alfalfa, it at the same time built up a vast export trade in agricultural produce in which the rest of the country has had but a trifling share. Of the 31·37 million acres under the five cereals and linseed in Argentina on the average of the years 1919-23, no less than 27·77 million were in the Pampa and less than 1½ million acres in parts of the country other than the Pampa and Mesopotamia—a ratio that has remained with the decline in those crops.

The Argentine exports of meat rose to a maximum of 600,000 tons during the period 1930 to 1944, but have since declined sharply owing to rising domestic consumption. However, as the aggregate production of cereals and linseed has fallen considerably, and the exportable surplus still more so, pastoral products have regained their lead in the export trade; these contributed 52 per cent of the total exports in 1956, the cereal group less than

¹ Census figures of cattle and sheep in Argentina (millions):—

	Argentina.		Buenos Aires Province.	
	Cattle.	Sheep.	Cattle.	Sheep.
1914	25·867	43·226	9·090	18·776
1922	37·065	36·209	15·508	12·902
1930	32·212	44·413	10·663	13·176
1945	34·010	56·182		
1952	45·26	54·68	18·10	14·76

40 per cent. Much of the previous expansion of arable arose from tenant farmers (*charcreros*) who leased land on the large *estancias* on a crop-sharing basis, and when after a few years the land showed signs of exhaustion, these people moved on elsewhere and the land was sown to alfalfa. The system was, perhaps, a little primitive, but at all events it provided, through the periodical return to grazing, against the exhaustion of the soil. Since also, alfalfa is capable of fixing atmospheric nitrogen in the ground, and the Pampa soils are very deep, the system may be continued for a long time without it becoming necessary to use fertilizers extensively. From what has been said above concerning the drainage of the Pampa it will be clear that the soluble fertilizing elements in the soil are not likely to leach out in the same way as in other regions where there is a vigorous run-off of rain water.

The future of agriculture on the Pampa will depend in some measure upon fluctuations in the comparative prices of cereals and of pastoral products. From 1920 to 1940 relative net returns were in favour of cereals on the Pampa, hence the expansion of arable farming there. Since 1945 two major developments have contributed to changes in the disposition of Argentine resources; the European markets for grain have contracted with the intensification of agriculture, notably in Britain; and the Argentine withdrawal from the previous dependence upon exports of primary products towards general diversification of industry and the development of manufactures has caused the land to lose labour to the towns.

Several factors have hindered the full development of agriculture on the Pampa. Many of the tenant cultivators were peasants from Italy and Southern Europe who were bent simply on extracting whatever they could from the soil during their term of occupation. The land was held in very large estates by the great *estancieros* or cattle kings, and the Argentine Government has found extraordinary difficulties in breaking these up and thus establishing a settled agricultural population with an interest in the land and a stake in the country. The crops are damaged occasionally by floods, more often by droughts, and occasionally by locusts, and are liable to marked fluctuations in yields. Transportation is on the whole efficient so far as the railways are concerned, and the construction of a system of grain elevators has been taken in hand, but the chief port, namely Buenos Aires, is congested, and the lack of roads to connect outlying districts with the railways is most striking.

Of the land under cultivation in the years 1933-40 in the Pampa and the river provinces, excluding that under alfalfa,

37 per cent was devoted to wheat which, in contrast with the sharp declines in maize and linseed, held nearly the same proportion of the smaller total arable in 1956. Wheat is therefore

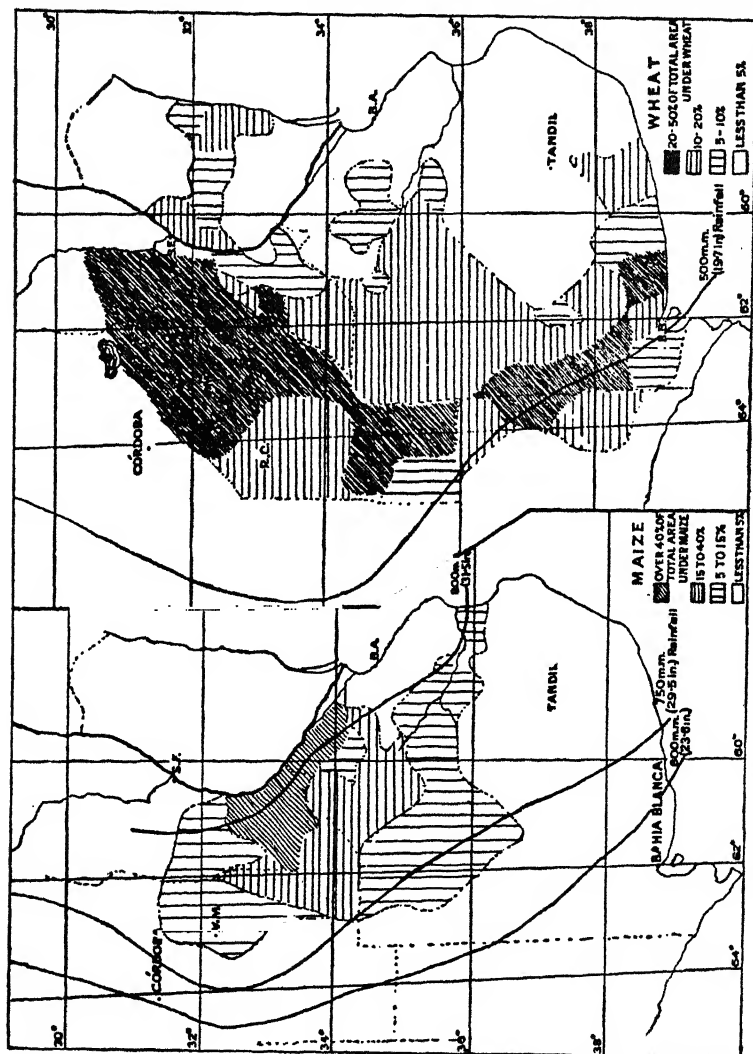


FIG. 27.—Wheat and Maize areas on the Pampa and in Entre Rios

the leading crop now, though exceeded in pre-war years by maize in yield, the former averaging 6 million and the latter 8½ million metric tons in 1938-40. The wheat area extends from Córdoba, which has the largest area of any province, into

the southern part of Santa Fé and into Buenos Aires, with outlying sections in Entre Rios and La Pampa. In the latter area the relatively heavy winter rains enable it to extend into a region with less than 20 inches of rainfall. The northern and north-western limits of wheat cultivation are fixed by the zone of heavy summer rains, the western and south-western limits by the increasing aridity, and the southern limit by the low temperatures as well as by dryness. Towards the eastern districts of Buenos Aires the wet soils are unfavourable to wheat or to agriculture in any form and the land there is mainly under permanent pastures.

The maize belt is practically restricted to Santa Fé, south-eastern Córdoba and north-western Buenos Aires. In the southern part of the belt frost is a limiting factor, while towards the west in Córdoba, maize gives place to wheat with the decrease in the rainfall. Very little maize is grown in Entre Rios or Corrientes, though the climatic and other conditions appear favourable. In the northern districts of Buenos Aires the maize belt is overlapped by the wheat belt, but the two do not coincide. Maize is grown in the districts adjoining the lower Paraná and wheat in the cooler and drier regions to the west and south-west.

Linseed has been a very important crop in Argentina, which exported in the years 1937-39 an average of $1\frac{1}{2}$ million tons per annum, about 80 per cent. of the supplies that entered into international trade. The area in which linseed is grown coincides with the maize and wheat zones, but does not extend so far as the latter into La Pampa Province. Production declined sharply, however, from the pre-war peak of $1\frac{3}{4}$ million tons to less than a third in 1950; and as most of the reduced crop has been processed in Argentina, exports of seed have been small.

The other important grain crops in 1955-56 were oats, rye and barley. Oats are cultivated in the cooler south-eastern districts of Buenos Aires Province from Tandil to Bahía Blanca, whence the surplus is exported. Barley has become an important crop in the northern part of the wheat belt, and rye (partly for animal fodder) has been grown in increasing quantities throughout the cereal lands.

In pre-war years, the bulk of the maize, linseed and oats produced in the Pampa-Entre Rios region was exported. Except for some maize and inferior grain to pigs and poultry, and some oats to horses, little of the fodder group in Argentina was fed to livestock. Cattle, including dairy cattle, as well as agricultural horses, were maintained chiefly on grass and alfalfa. The country was, in fact, exporting the accumulated fertility of the

soil in the most direct way possible, by exporting "raw" agricultural products in the form of large consignments of such feeding stuffs as maize and linseed. Since 1940, however, the production of maize has fallen to less than half the pre-war average, and that of linseed to less than a quarter. At the same time, in keeping with the nationalist economic policy, increasing proportions of those reduced crops are either fed to local livestock or are processed within the country.

The dairy industry of eastern Buenos Aires was an exception to the general pre-war practice. This increased notably after 1914 till in inter-war years, after meeting local requirements, the dairying districts were exporting butter in such quantities as to make them one of the major sources of that product in international trade. There have also been appreciable exports of cheese, and, although the surplus of dairy produce has fallen from the 1923-27 level, this is not so much because the dairying industry is receding as because the home market is expanding.

Manufacturing industries, other than the special ones concerned with the preparation of meat in freezing works and the milling of wheat, have developed greatly since 1930 and many articles of domestic consumption are now made in Buenos Aires. In spite of its poverty in locally-produced fuel,¹ however, the country seems to be making a determined attempt by means of increased protective duties to encourage domestic manufactures. Any success that attends these endeavours will simply add to the wealth and importance of Buenos Aires, already a very large city in proportion to the total population of the country. (See Note, p. 185.)

The whole life of the Pampa depends upon the railways that radiate from its three great outlets, Buenos Aires, Rosario and Bahía Blanca. Even the navigable highway of the Paraná would be nearly useless without the railways that act as feeders to it. In these circumstances, it is natural that settlement in the modern sense should advance only with the construction of lines into the outlying districts, and that, in the absence of private enterprise to build extensions, the government should feel it necessary to take these in hand. The trunk lines across the Pampa having been more or less completed prior to 1914, practically all the new railway construction there since that date has been due to state initiative; and this applies also to the rest of Argentina.

In the pre-railway era there were several important overland routes that crossed the Pampa in one direction or another.

¹ The 4 million odd tons of petroleum produced in Argentina cover less than half the country's requirements of that fuel.

One led due west via S. Luis and Mendoza to Chile, a second was the great route to Peru via Córdoba and points beyond, a third linked Santa Fé with Córdoba, and another was the salt track to the salares of Southern Buenos Aires. All of these are now followed by trunk railways which with the new motor roads have superseded other means of transport on the Pampa.

A detailed description of the network of railways in the Pampa would occupy too much space; only the general outline can be attempted. From the historical standpoint railways began, as did the first Spanish settlement, from a point north of Buenos Aires up the Paraná. The first main railway built in Argentina was that from Rosario to Córdoba, completed in 1865, the link with Buenos Aires being the next step. It is noteworthy that Mendoza was connected with Rosario before the line from Buenos Aires to Villa Mercedes was completed; but once Buenos Aires came to be used as a starting-point, it soon definitely took the lead as the chief railway centre. One reason for the emergence of the two rival foci of Buenos Aires and Rosario in railway construction was the existence of the navigable river between them. Even now there is little competition for goods traffic between the railways and the Paraná as far up on the latter as the limit for sea-going ships.

Owing to various fortuitous circumstances the main railways in Argentina have been constructed in three different gauges: the broad (of 5 feet 6 inches), the standard, and the metre. Built on the first of these gauges, four great systems now radiate from the City of Buenos Aires. The Buenos Aires and Great Southern,¹ with three main lines, covers the eastern and southern parts of Buenos Aires Province as far as Bahia Blanca and thence extends right across Northern Patagonia as far as Zapala just east of the Andes, at which point a connection with the Chilean railways is planned to be undertaken (see p. 58). The Buenos Aires and Western, likewise with three main lines beyond the Salado, works the western and south-western parts of Buenos Aires Province and has had an arrangement with the Southern by which it has running rights into Bahia Blanca. The Buenos Aires and Pacific has a main line nearly due west to Villa Mercedes. From this line two important tracks branch off at Rufino, one north to Villa Maria where it meets the Central Argentine, and another south-west and west to San Rafael. The arterial line continues westward from Villa Mercedes to Mendoza, whence branches run to S. Juan and again to S. Rafael. The last of

¹ The names (since changed) here used to denote the Argentine railway systems are those by which they were known under former foreign, mainly British, ownership.

these four great broad-gauge systems is the Central Argentine, which, with several main tracks between Buenos Aires and Rosario, connects the latter centre with Córdoba via Villa Maria and thence continues to Santiago del Estero and Tucumán.

The standard-gauge railways comprise; first, the Central of Buenos Aires, which extends in a north-westerly direction from Buenos Aires and is completely enclosed by the Argentine Central and Western systems; second, the Entre Rios Railways whose main terminus is Ibicuy on the Paraná; and third, the Argentine North-Eastern, mainly in Corrientes. The through connection from Ibicuy to Posadas by the last two systems was completed in 1911 (see p. 57).

The most important metre-gauge railways within the region are the Buenos Aires Midland, the Province of Buenos Aires and the Buenos Aires Provincial lines which work a zone on the borders of the Great Southern, and the Western broad-gauge systems. The first two of these have their termini in Buenos Aires, the third in La Plata. It is worth noting that the great state system in North-Western Argentina, with its connections towards the Pampa, is built to this gauge.

A connection north and south on the western zone of the Pampa is effected by a line belonging to the Pacific system linking Villa Mercedes with Bahia Blanca, while farther east the Rosario and Puerto Belgrano connects the Paraná port with the same southern outlet.

Of the three main ports, Buenos Aires naturally handles far more traffic than either of the others; but owing to the congestion there, the tendency is to work more of the grain other than maize down to Bahia Blanca, where elevators have been constructed to provide proper facilities for handling it. The greater part of the exports of maize take place through Rosario as the natural outlet of the maize belt. Some maize, however, is shipped at Santa Fé, the fourth port of the Pampa and on its extreme northern edge. In order to make these river ports accessible to modern vessels, the Paraná has been dredged to a depth of 21 feet as far as Rosario and to 19 feet as far as Santa Fé. In the meat trade Buenos Aires, with its outports of La Plata and Zarate, is much the greatest centre, but freezing works have been in existence for some time at Bahia Blanca, and similar works were constructed later at Rosario.

Before the onset of the decline in bulk exports of agricultural produce from the Pampa, it was evident that some measure of decentralization in the export trade was necessary to relieve pressure upon the port of Buenos Aires; and in the movement of cereals this was done within the narrow limits set by the

relative costs of railway haulage. Now in reverse, Buenos Aires is threatened with congestion in import trade, especially in raw materials, owing to the growth of manufactures concentrated in and round the city.

No important provincial centres have arisen at intermediate points across the Pampa in any direction. Such towns as Córdoba, Villa Maria and Villa Mercedes are situated on its western margin, in the transitional zone between the Pampa and the regions beyond distinct in type from it. In short, the centres of population and commerce comprise primarily the two great and closely-linked ports of Buenos Aires and Rosario, and after these a ring of towns—Concordia on the Uruguay, Santa Fé on the Paraná, Córdoba and Villa Mercedes in the west and Bahia Blanca in the south. Between the hub and the circumference lies a great arc of rich plain whose produce gravitates to the estuary head or to Bahia Blanca, and across which is conveyed the produce of the regions lying beyond in the interior, first collected at the points on the circumference. The Pampa and Entre Rios are engaged in agricultural and pastoral production, not in commerce. Such traffic as passes through them makes its way without pause to and from the emporiums open to the Atlantic.

NOTE ON RECENT ECONOMIC DEVELOPMENTS IN ARGENTINA

Since the world trade depression 1929-32 which severely shook the previously stable Argentine economy, changes have taken place in the country's industries and financial and transport systems. In agriculture, the production of essentially export crops such as maize and linseed has declined, while that of barley, and especially of cotton and oilseeds, has increased; of the latter the sunflower seed crop amounted in 1944-45 to a million tons (though since declined) and of groundnuts to 160,000 tons. In the live-stock industry there has been some substitution of dairy for beef cattle and of wool for mutton sheep, and a great increase in the number of pigs.

Manufactures, concentrated largely in Buenos Aires and neighbouring towns, have expanded greatly in spite of shortages of fuel, machinery and some raw materials. The chief branches, in order by number of workers, are the food and beverages group, textiles, metal manufactures, the construction of machines and vehicles, and chemicals.

On the financial side, rising prices for exports in the war period turned the debit balance of the early 1930's into a large credit balance, but this has since been offset by contraction of exports and increased imports of materials and capital goods for industrial development. Arising out of the elaborate exchange control of the depression period, government control of finance and foreign trade and of marketing organization has greatly increased. The state railway system has been vigorously extended into the peripheral regions, e.g. the Chaco and Patagonia, the Government now owning and operating the whole 29,300 miles of Argentine railways. Recently, also, a large programme of road construction has been carried out with a view to integrating the whole inland transport system.

CHAPTER XV

THE CHACO LOWLANDS AND THEIR SOUTHERN EXTENSION

FOR a distance of upwards of 1,100 miles north and south, from the low divide at the headwaters of the Mamoré and other rivers in Bolivia to the northern edge of the Pampa in Argentina, extends an immense area of ill-drained lowlands occupying more than 400,000 square miles. The name Chaco (hunting-ground) which has been applied to the southern part of the region in both Argentina and Paraguay, can be conveniently used to denote the whole of it. The Chaco, thus defined, is a great basin of sedimentation, lying between Brasília to the east, and the Pampa sierras and the Sub Andes to the west; it has been built up on a sunken section of the former, with the waste mainly of the latter. Its northern boundary is the low bridge running N.E. to S.W. in continuation of the continental watershed across the Brazilian Plateau. Its southern boundary likewise runs in general diagonally across the continent, but in the opposite direction, namely from N.W. to S.E.—from the Pampa sierras in Catamarca and Córdoba passing south of the Mar Chiquita, then almost due east to a point on the Paraná a short distance above the town of Santa Fé.

The Chaco region as a whole falls gently towards the east and south-east, but its general elevation is low. The Paraguay River at Asunción, for example, is only 204 feet above the level of meantide water at Boca just below the Paraná delta; and for hundreds of miles north of Asunción there is but little rise in the bed of the Paraguay River. The streams from the Andes that traverse the Chaco follow ill-defined and almost level courses after entering the plain. Throughout the Chaco, accordingly, rivers have little or no erosive power; on the contrary, they are unable to carry the loads of sediment they bring down from the neighbouring uplands.

The remoteness of the Chaco from the seaboard, its inaccessibility from all sides except the south, the uncertainty of its water supply, the plagues of insects which infest it, the diffi-

culties of travel within it and the hostility of the Indians, are all factors that have hindered settlement and limited exploration. Except on the southern margins in Argentina there are very few people of European descent living in the region, and large parts of it remain completely unknown except to roving tribes of Indians. Though by no means so densely forested as Amazonia, the real Chaco is more difficult to penetrate, since it contains no easily navigable rivers except the Paraguay on its eastern border. The Spanish came to know of the existence of the Chaco early in the sixteenth century, but failed to make any permanent settlements in it. Since that time till quite recently it has been more or less completely left alone, for its resources have not been of a kind, nor of such ready availability as to attract adventurers from what were but sparsely settled regions nearer the sea, where Nature was in one way or another more bountiful.

Two outlying and somewhat transitional sections of the Chaco region, however, one on the south-western and the other on the south-eastern border of the Chaco proper, have been actively exploited for some time and have seen the establishment of permanent settlements. The first of these is in the province of Santiago del Estero, and the other lies in a belt along the Paraná and Paraguay Rivers from Central Santa Fé to the latitude of Asunción. Each will be described in some detail in discussing the industries of the region as a whole. The first attack upon the interior Chaco has been made recently along a line north of the Bermejo River, which is partly navigable. The Formosa railway, now constructed to Embarcación along the stretch of open country between the Bermejo and the Pilcomayo, links the second of the partly developed zones mentioned above with the line of penetration working north-east in the foothills region from Salta to Orán and Embarcación on the Bermejo and beyond to Yacuiba on the Bolivian boundary.

With the advance of the low-pressure system in summer from the north over the Chaco, the rainy season sets in. Heavy precipitation then takes place not only on the plains themselves but also on the eastern Andes. The rivers become flooded, and, since their banks are generally very low, they spread themselves over wide areas. In this way seasonal lakes of various types and huge marshy tracts are formed. So numerous and so characteristic are these flood areas throughout the Chaco all the way to the borders of the Pampa that special names have been given to the different types. Thus the place where a river spreads itself out temporarily without a recognizable channel or proceeds by infiltration, is called an *explayado*; an area that re-

ceives overflow water or the whole discharge of a disappearing river and from which the water is afterwards removed by evaporation so as to leave salt incrustations is known as a salitral; an undrained hollow that receives flood waters that afterwards dry up and in which the fine sediment carried by them is deposited, is described as a bañado; an estero is a deeper bañado, some parts of which are always under water; while a malezal is a swamp caused by the drainage water over a wide area having such an imperceptible fall that it cannot flow away; and a laguna is a permanent sheet of water resembling a lake, found only in the low ground near the Paraguay.

Rivers that traverse districts in which these departures from normal drainage occur, frequently change their courses. Indeed, several of the abnormalities described above owe their existence to this habit in the rivers. The bañado and the estero, in particular, generally occupy abandoned channels and are consequently elongated in outline, while the salitral, since it occupies a hollow between slight elevations aligned with the river and may even represent an advanced stage in the filling up of an estero or a bañado, likewise tends to be long and relatively narrow. The explayado and the malezal, on the other hand, occupying areas of flat land, are of quite indefinite outline and the same applies to the more permanent and aggravated forms of water-logged country up to the cañada or true permanent swamp.

The climatic conditions on the Chaco, combined with the peculiar drainage, are distinctly unfavourable to the utilization of the soil resources. Theoretically, the region comprises immense areas of fertile alluvial lands, but great sums of capital will have to be expended on drainage, on the sinking of wells and on water-storage works before the potential agricultural wealth can be made available. The long dry season imposes a formidable obstacle in the naturally better-drained areas just as the excess of surface water does during the rainy season in the extensive low-lying areas. Owing to the almost horizontal arrangement of the strata springs are rare, and the utmost difficulty is encountered in obtaining supplies of drinkable water when the wet season is over. Thus exploring parties have actually to carry water with them into a region where during three months in the year travel is impossible owing to the succession of morass and lake.

The variations in the natural vegetation throughout the region are closely related to changes in the natural drainage. Much, both of the section south of the Pilcomayo and of the Paraguayan Chaco, is forested, at all events, on the higher-lying

parts. The forest is in some places dense, but generally rather open, and broken by numerous smaller or larger savannah tracts or swamps. Altogether only about 50 per cent of the southern region is actually covered with trees, among which several species of quebracho are characteristic and have given rise to the name of quebracho forest to this belt extending as far north as about 22° S.

On the western edge of the Chaco, where the surface begins to rise towards the Andes and where the rainfall is somewhat better distributed throughout the year, the quebracho forest gives place to the mixed evergreen type of tropical forest, which farther north becomes continuous in Eastern Bolivia and Mato Grosso. Beyond the Pilcomayo, on the eastern side of the Chaco, the quebracho forest becomes thinner and more patchy and finally disappears. It is succeeded by a mixed flora in which palms are common, especially in the ribbon forests along the water courses and esteros, but which consists as a rule of savannah or swamp vegetation. In the extreme south of the Chaco lowlands, on the other hand, in the district lying on either side of the boundary between Santa Fé and Santiago del Estero provinces, the climate and the soil are unfavourable to the quebracho trees and the forested areas assume the characteristics of the hardwood type of the dry tropical and sub-tropical regions of the continent.

The most striking feature in the natural vegetation is its lack of uniformity. True forest belts, palm groves, patches or strips of tall tropical grasses, swampy tracts and true open grasslands succeed one another at intervals. Changes in the courses of the rivers will cause corresponding changes in the arrangement of these different vegetational types. In fact, one of the common causes of interference with the channels of rivers is the growth of totora or tropical grasses in them during the dry season. Thus not only is the distribution of vegetation in the Chaco highly sensitive to the arrangement of the drainage and the consequent position of the water-table in different places, but the drainage itself is readily affected by changes in the nature of the vegetation favoured by seasonal variations in the climate.

In these circumstances the streams other than the Paraguay that drain the Chaco lack those features of definiteness and permanence common to streams elsewhere. The annual dry season, during which most of them either cease to flow or become very small in volume, deprives them of the advantage of uninterrupted possession of their channels. At each flood they deposit sediment both in their beds and along their banks, especially as

the water subsides. Sooner or later, the whole stream is raised above the level of the surrounding plains and then is apt to burst its banks on the slightest provocation and to wander at large over the surrounding country. The encroachment of vegetation upon the bed of the stream during the dry season simply hastens this process, not only by the resistance that the dense growth of plants offers to the current of water, but also and to a greater extent through the manner in which such vegetation arrests the sediment that would otherwise be carried farther. The Chaco rivers diminish in volume and weaken as they pro-

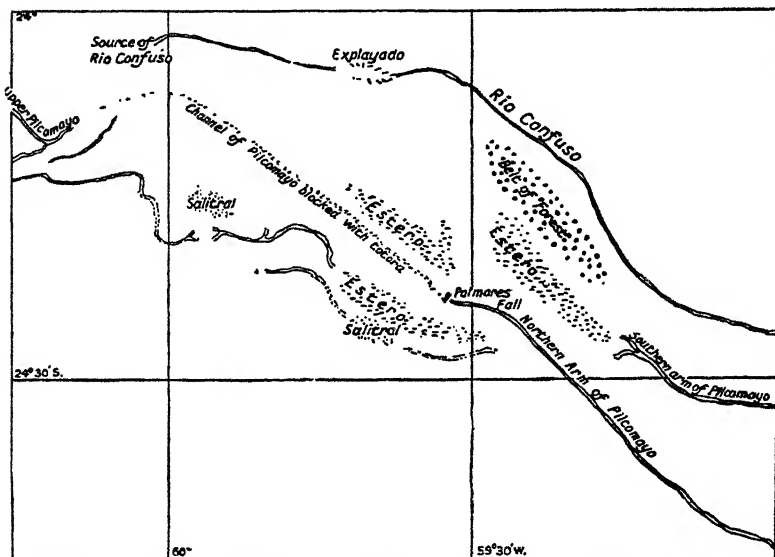


FIG. 29.—Part of the middle course of the Pilcomayo

ceed across the plains, and these features are due in some measure to the fact that they receive no tributaries after entering it.

The chequered course of the Chaco rivers, their lack of continuity and the frequent occurrence of longitudinal overflow basins such as esteros and salitrals, are well represented in the small section of the middle course of the largest, the Pilcomayo, shown in Fig. 29. A study of this map will make it clear that navigation on such rivers, except in stretches where the channels are clearly defined, is quite out of the question. Nor is it surprising that the 700-mile course of the Pilcomayo was not completely traversed until after a number of unsuccessful attempts had been made.

Of the other rivers in these lowlands the Bermejo is next

in size to the Pilcomayo. Shortly after it enters the plain, however, it breaks up into a maze of channels old and new between 23° and 24° S., below which it has recently shifted its bed some 20 miles to the north-east along a distance of more than 250 miles. A certain amount of water finds its way into the Old Bermejo channel in times of flood, but the main volume then, and the whole of it during the dry season, follows the course of the New Bermejo or Teuco. The Old Bermejo has thus been doomed to become nothing more than a succession of esteros and saline depressions, while the New Bermejo, being quite a recent affair, is comparatively free from obstructions for the present. The lower Bermejo, occupying a normal channel, is navigable up to the point where the new river joins the old.

The Rio Salado or Juramento has already been mentioned in the previous chapter, since it passes into the Pampa before discharging into the Paraná. Its 500-mile course through the Chaco is quite characteristic. Before entering the plain it is some 120 yards wide, but in its lower course it is only 15 to 20 yards wide and in the dry season degenerates into a mere winding ribbon of water. In any case the amount of water it gets from the snows of the Andes is small compared with that which is brought to its channel by the rains, and in this respect the other Chaco rivers are similar. Scattered along the course of the Juramento are numerous lateral lagoons which become filled with water in the wet season and serve as reservoirs that gradually empty themselves into the river as it subsides. At three different points in its course through the Chaco this river is more or less completely interrupted by esteros in the same way as is the Pilcomayo, but the climate being somewhat drier, these do not tend to become choked with rank vegetation to the same extent, and considerable quantities of maize and other food-crops are grown on the margins of the esteros and in the *bañados* both of the Juramento and of the Rio Dulce or Saladillo.

The last-mentioned river rises in the Sierra de Aconquija in Tucumán and then flows south-east in the same general direction as the other Chaco rivers. Like them it becomes a broad stream in the rainy season, being then nearly a mile wide in the neighbourhood of the city of Santiago, but contracts to a small stream in winter. About latitude 30° S. it flows into the Los Porongos Lagoon or series of lagoons and thence into the Mar Chiquita which has no surface outlet. In that part of its course which lies in the departments of Loreto, Atamisqui and Salavina the Rio Dulce has been notorious for changing its course, no less than six such alterations having taken place in quite recent times. The river now flows close to the northern edge of the Sierra de

Córdoba and is therefore on the extreme southern limit of the Chaco lowlands in that section.

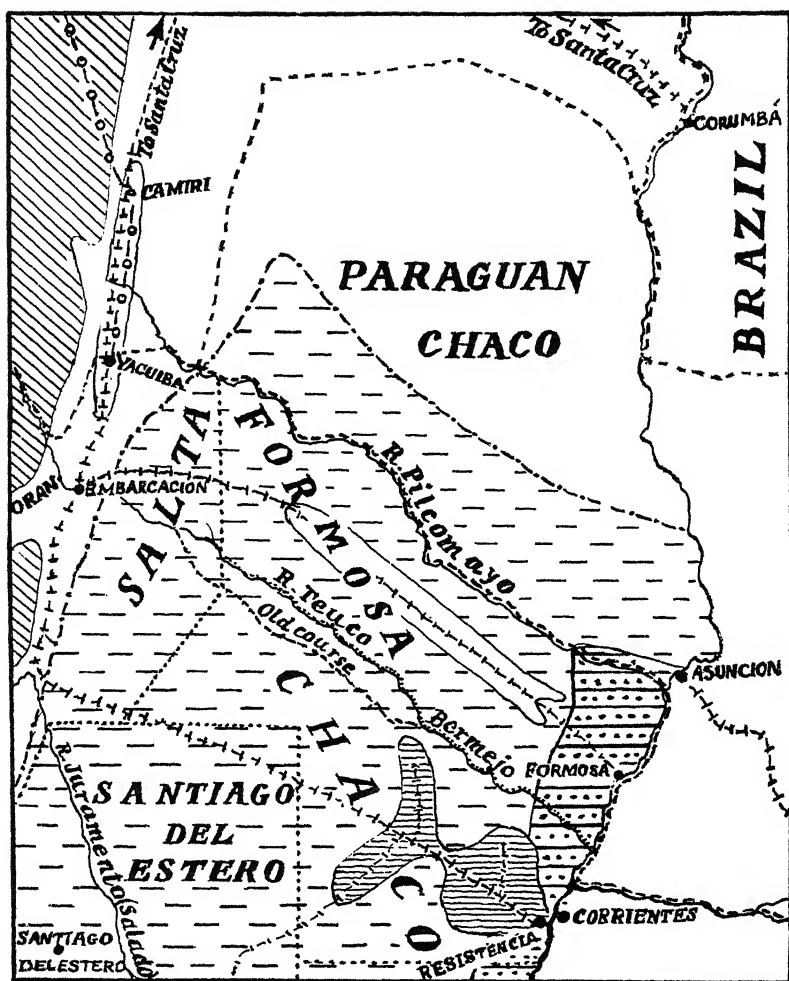
The above survey of the main rivers of the Chaco shows that they all have striking points of resemblance in the nature of their courses and in their behaviour. These features constitute, in fact, eloquent testimony as to the peculiarities of the region traversed by the rivers, and as to the problems that will have to be solved, if anything more than the outskirts of the region are to be settled. Various other smaller rivers drain the Paraguayan Chaco north of the Pilcomayo, but concerning these little is known except that they have much the same peculiarities as the larger rivers to the south. That section of the Chaco region which is in Bolivian territory apparently differs somewhat from the great plains in Paraguay and Argentina. Its southern part is one of the least known and most thinly populated regions in the habitable areas of the world. Towards the north of the Bolivian Chaco, in what is known as the Llanos de Chiquitos, there is a series of low hills running from N.W. to S.E., with a general fall from the continental divide in the same direction. Here once more the drainage follows the same south-easterly course as elsewhere in the great region of interior lowlands in South America, except in their swampy continuation east of the Paraguay in Matto Grosso. There the geological setting differs from that of the main zone west of the Paraguay. Instead of vast tracts of alluvial material resting horizontally upon yet other similar deposits, such as are found between the Paraguay and the Andes, in Western Matto Grosso there is a lowland amphitheatre excavated by the upper Paraguay out of the soft sandstone rocks of the great plateau.

During the greater part of its course the Paraguay lies close up against the hard rocks of the Brazilian Plateau as the Uruguay does lower down. There is every indication that the sediment brought down in the course of long periods of time from the Andes has been chiefly responsible for forcing the arterial drainage line to its present easterly position, though the higher rotational velocity of the upper courses of the great rivers may also have been a contributing cause in their eastward swing lower down. Considered as a physiographic unit the Chaco is still in the process of upbuilding through deposition by rivers. When they have raised the level along their courses to a given point above that of the surrounding country, they wander away and carry out the same process elsewhere, and so on indefinitely. Thus in the end the surface-level of the whole region becomes gradually raised. Eventually, of course, in the absence of earth movements up or down, the general level of the Chaco will be

so far lifted that a definite fall will be possible in the beds of the rivers all the way between the Andes and the Paraguay-Paraná channel. From that time forward a cycle of erosion will tend to set in; the rivers will begin to excavate valleys and the whole drainage system to assume a fixed arrangement. Now, however, and for ages to come the region will show the chaotic features of a place where the work of land construction is in progress on a large scale. Man may do something to make the process more orderly here and there, but not very much.

The greater part of the Chaco thus remains one of nature's wildernesses left to Indian tribes who, like the region they inhabit, are for the most part wild and difficult to subjugate. Their numbers are apparently small—according to one eminent writer, there are not more than 50,000 to 60,000 of them in the whole Chaco area south of the Corumbá-Santa Cruz line—but the "wild" Indians are fierce and dangerous, especially the Tobas and Matacos in the regions north of the Pilcomayo. In resisting intruders they have the advantage of knowing the difficult country and of being able to use the stretches of forest and other vegetation as cover from which to launch their attacks. When it is remembered that the comparatively open country on the route from Buenos Aires to Tucumán and Bolivia was not finally freed of Indian attacks till long after the conquest, the difficulties of making the Chaco interior safe from these tribes can be appreciated. The region north of the Pilcomayo is still very much a no man's land, and the claims made by both Paraguay and Bolivia to large slices of territory in it have little meaning until one or other of these countries is strong enough not only to undertake the complete subjugation of the Indians, but also to follow it up by some measure of settlement.

Argentina, however, working northward from the strong base-line of the Pampa and of the north-western route, has begun definitely to take in hand the economic conquest of that part of the Chaco which is within her territory. This movement is advancing on three fronts: that of the Paraná and Paraguay, that of the north-western route from Santa Fé to Tucumán, and that of the Andean foothills. Though as yet the zone of effective penetration towards the interior from each of these lines is narrow, each zone is characterized by a separate industry already established and giving promise of expansion and long existence in the future. Along the Paraná there is the quebracho industry, from the Paraná to Santiago del Estero there is agriculture with cotton-cultivation making rapid strides, and along the strip adjoining the Andes there is cattle-rearing. These industries will now be discussed in order.



SUB-ANDINE ZONE

AREA OF QUEBRACHOS OF
ALL KINDS

AREA OF QUEBRACHO
FACTORIES

CHACO COTTON GROWING
AREA



SALTA-BOLIVIAN PETROLEUM
BELT AND PIPELINES



RAILWAYS



INTERNATIONAL BOUNDARIES



FIG. 30.—The North Central Chaco Region : Modern Developments

The quebracho zone extends from the northern part of Santa Fé province in a northerly and north-westerly direction through the Argentine Chaco, the province of Santiago del Estero and the Formosa Territory, into Paraguay and Bolivia. The belt thus stretches a distance of some 750 miles along the Paraná-Paraguay line, but it reaches west from that line over a width that varies greatly, in some places not more than 25 miles, in others up to 200 miles. The quebracho tree is sensitive to the moisture content of the soil, and since in the more or less impervious soils of the region a slight difference in level makes a great difference in the amount of water available at the roots of the trees, not only is the quebracho forest belt proper of very unequal width, but the stands of trees within it are apt to be patchy. On the low-lying lands near the Paraguay and the Paraná, the summer rains tend to run off, or filter through, slowly, and thus to produce general swampy conditions. The quebracho avoids both the slightly elevated tracts, which get very dry during the winter, and the depressions occupied by permanent swamps. The best forests both for density and for quality of trees were originally in Santa Fé province, beginning about 10 miles back from the Paraná; but with the heavy cutting that has taken place for a number of years past, this section is becoming less important and the first place is being taken by the Argentine Chaco where also the forests attain their maximum width.

Three main varieties of quebracho are recognized, the colorado, the blanco and the macho, of which the first or true quebracho (*Quebrachia lorentzii*), known locally as the quebracho chaqueño, is most widespread and is most extensively exploited for the extraction of tannin. Its wood is very hard, and this feature accounts for the origin of the name quebracho (axe-breaker). In addition to being hard, the wood of the true quebracho is strong and durable and is highly serviceable for building purposes and especially for making posts and railway sleepers. White quebracho, which occurs extensively towards the west and grows in wetter ground than the true quebracho, yields a timber that is neither so hard nor so durable and contains a much lower percentage of tannin. It is used chiefly for fuel, but to some extent for making wheels and for building purposes. The macho and several other species of quebracho are found in various parts of the Chaco region, but are not of common occurrence, so that although the macho, at all events, is rich in tannin, none of them is used except for purely local general purposes.

Other trees are found growing in the quebracho forest region; either mixed with the various species of quebracho or filling the spaces where the conditions are unfavourable to the latter.

These miscellaneous trees are generally left standing except in Santa Fé, where nearness to the great Paraná highway makes it worth while to cut some of them for dispatch to the great markets of the Pampa. The quebracho trees are utilized for different purposes, varying not only with the species, but also with the density of the stands and the quality of trees, and their situation with reference to means of transport. In general, those with low tannin content such as occur in the western forest area in Santiago del Estero, and especially the dead trees in the monte quemado or burnt forests, are utilized for firewood, for the manufacture of charcoal, or for timber. Obviously these branches of the industry are likely to be unprofitable except within reach of railways; it is simply to minimize transportation costs that inferior and dead wood is widely converted into charcoal on the spot.

The cutting of quebracho for tannin assumes two types of industry: either that of preparing logs for dispatch to the centres on the lower Paraná and the La Plata Estuary whence they were frequently exported, or that of combined cutting and extraction in the forest region. The former method of exploitation has lost to the latter in Argentina, in the period since 1913, as shown by the following export figures (in metric tons):—

	Exports of Logs.	Exports of Extract.
1911-13 (3 years' average)	367,174	74,342
1931	88,762	175,845
1948-50 (3 years' average)	none recorded	173,000
1955	" "	115,272

From Paraguay no quebracho logs are exported, except as timber, but exports of extract averaged about 36,000 tons in the years 1949-55, some of which has been obtained from logs brought to the Paraguayan plants from over the Argentine border.

The combined cutting and extraction enterprises naturally tend to seek out areas that are heavily timbered with trees of good quality, because it is profitable to keep the factories working in the same place as long as possible. Since their product is valuable in proportion to bulk, they are much less dependent upon nearby means of transport than the simple cutting plants. Now that the more accessible forests near the great river highway have been cut over, the economic advantage is with the extract factories which have a much wider choice of location in the interior. This branch of quebracho exploitation is essentially one of large-scale capitalistic enterprise: the factories, once established, become more or less permanent, wood being transported to them when the trees in their immediate neighbourhood have been cut; light railways are constructed, skilled technicians

are employed to take charge of the whole business, houses are erected for the workpeople and land is allotted for the cultivation of crops.

The exploitation of quebracho shows a general northward movement in Argentina as the southern and more accessible forests get worked out, a process which takes place all the more rapidly since only the heartwood of the tree is used ; the sapwood and the limbs, containing from 5 to 10 per cent of tannin, are generally wasted. The quebracho tree is of slow growth and no attempt is made at replanting, so that the question of available resources is of moment in considering the future. According to estimates made, the total quantity of true quebracho wood remaining in the territory explored is about 75 million metric tons, of which at least half is in the Argentine Chaco Territory. Of the rest, upwards of two-thirds is in Santa Fé and about one-tenth in Paraguay. Small fractions in Santiago del Estero and in Formosa Territory account for the remainder. The quality of quebracho deteriorates noticeably towards warmer latitudes. In Paraguay, it is said, over half the trees are defective. Since Argentina possesses about nineteen-twentieths of the reserves of wood fit for extraction, the industry has to be regarded as mainly confined both now and for the future to that country. The total annual cut of quebracho throughout the whole region is estimated to average about 1 million metric tons, so that allowing for an underestimate of the total, which seems probable, this volume of supplies can be maintained till somewhat beyond the end of the present century. As, however, the demand of the rapidly growing population of Argentina for railway sleepers and for timber requirements is likely to expand a good deal as time goes on, and as, moreover, destruction by forest fires cancels new growth, the standing resources will probably be exhausted considerably earlier, unless the world at large is prepared to look less to this source for its supplies of tanning materials.

Agricultural development in the Chaco does not follow in the wake of the quebracho industry, since the eastern zone is unfavourable to colonization, but towards the south-west of the Chaco region where the climate and the soil are drier and the forest cover is thinner, a settled agricultural population is growing up in the districts served by the Central Argentine and other railways. For a long time attention was confined to the cultivation of food crops in favourable places for the forest workers, but more recently cotton cultivation has been taken up and the area so utilized has expanded rapidly. The acreage under cotton in Argentina, most of which is in the Chaco region, was a little more than 8,000 in 1914-15, rose to 317,000 in 1930-31, and to 950,000

in 1939-40. In the years 1954-55 Argentina produced an average of 118,000 tons of cotton, thus establishing a quantitative lead over Peru, hitherto the second chief cotton-producing country of the Southern Hemisphere. According to the reports of American investigators who have recently visited Northern Argentina, the total area in the Chaco suitable for cotton far exceeds the 30 million acres of the cotton belt in the United States.¹ By 1950 the area under cotton in the two northern provinces, Chaco and Formosa, had risen to about 1½ million acres, contributing fully three-quarters of the total Argentine production. The Chaco "cotton belt" extends along and westward of the lower Paraguay north-west of Resistencia. It is occupied by immigrant pioneer settlers who grow subsistence crops for their own needs in addition to the primary cash crop.

The cattle-rearing region in the Chaco naturally follows the zone just below the foothills of the Andes where, although the dry season is marked, streams are more abundant than farther east and the water-supply is thus more adequate. Unfortunately the whole Chaco region is north of the line from Santa Fé to the Sierra de Córdoba that marks off the region to the south free from the garrapata or cattle-tick, and consequently only hardy and somewhat inferior stock can be raised. The cattle belt in the Chaco extends from the upper Juramento beyond the upper Bermejo and even into the lowlands of Bolivia. The great centres for the trade in surplus cattle are Embarcación and Orán where they are collected from the north, and Salta, whence they are dispatched over the Andes and the Puna of Atacama to Northern Chile. In addition to this western cattle-rearing region, there is another and smaller one in the Paraguayan Chaco, adjoining the river highway.

An oil-bearing belt which extends from Embarcación in Salta Province of Argentina some 200 miles northwards towards Santa Cruz in Bolivia, has been exploited for some time past in Argentina and latterly in Bolivia. The largest producing centre there is Camiri, 150 miles north of Yacuiba, connected by pipe-lines with the latter town and also with refineries at Cochabamba and Sucre. Upon completion of the projected pipe-line to Oruro and La Paz this nationalized oilfield is expected to provide a surplus for export above Bolivian domestic requirements, not only to Argentina, but also from Pacific ports.

The limited traffic from these various border regions of the Chaco which have so far been exploited in some measure, finds its way directly either to the great river highway leading to the La

¹ The climate, however, is less favourable, owing to the risk of serious droughts, and pests are likely to be more troublesome.

Plata Estuary or is centred in such frontier towns as Santiago del Estero, Orán and Yacuiba. In the present stage of development interior centres are out of the question, for with the exception of the recently completed Formosa railway there is no means of transport within the region other than the pack-mule or bullock wagon.

CHAPTER XVI

THE PAMPEAN HINTERLAND AND THE PRE-CORDILLERAS

BETWEEN the lowlands of the Chaco and of the Pampa to the east, and the lofty Andes to the west, lies a somewhat narrow and elongated intermediate zone extending from the Bermejo (lat. 25° S.) to the Rio Colorado (lat. 37° S.). In relief it offers a striking contrast to the simple configuration of the plains into which it drains. Little of it is level except the arid tracts in the Salinas Grandes and in the south-eastern section in San Luis and in La Pampa Territory. Elsewhere it consists of mountain ridges with intervening deep valleys, and finally mounts, either on long slopes dotted with alluvial fans or in the form of a steep wall, to the eastern summits of the Andes.

The region reaches its easternmost extension in the Pampa Sierras in Córdoba and San Luis. Behind them lies a broad, irregular valley which opens southwards on to the steppe lands west of the Pampa, and upon which several deep and narrow valleys debouch from the western mountains. These valleys lie more or less north and south, and are marked off from the Andes and from one another by a series of five pre-cordilleran chains, that nearest the Andes comprising the Sierras of Tontal and Paramillos, and the others in order eastwards being represented by the Sierras of Famatina, of Velasco, of Ambato and of Ancaste. Between the southern terminations of the last three of these ranges and the Pampa Sierras runs the northern outlet of the broad pre-cordilleran depression above referred to. This outlet valley is very hot and dry, and evaporation in it is so intense that a large part of the floor is covered with incrustations of salt, whence the name Salinas Grandes. North-eastwards the valley leads to the border of the Chaco plains in the province of Santiago del Estero.

The pre-cordilleran ranges, which become marked in the latitude of 30° S., link northwards with the broad mass of the Andes in the region of the Puna de Atacama, but they are succeeded immediately by other similar detached or semi-detached ranges that strike out from the Andes in a bewildering fashion in

slopes of the Cordillera Real, but there the distinctive feature of high outer ranges with deep intervening valleys is lost, and the

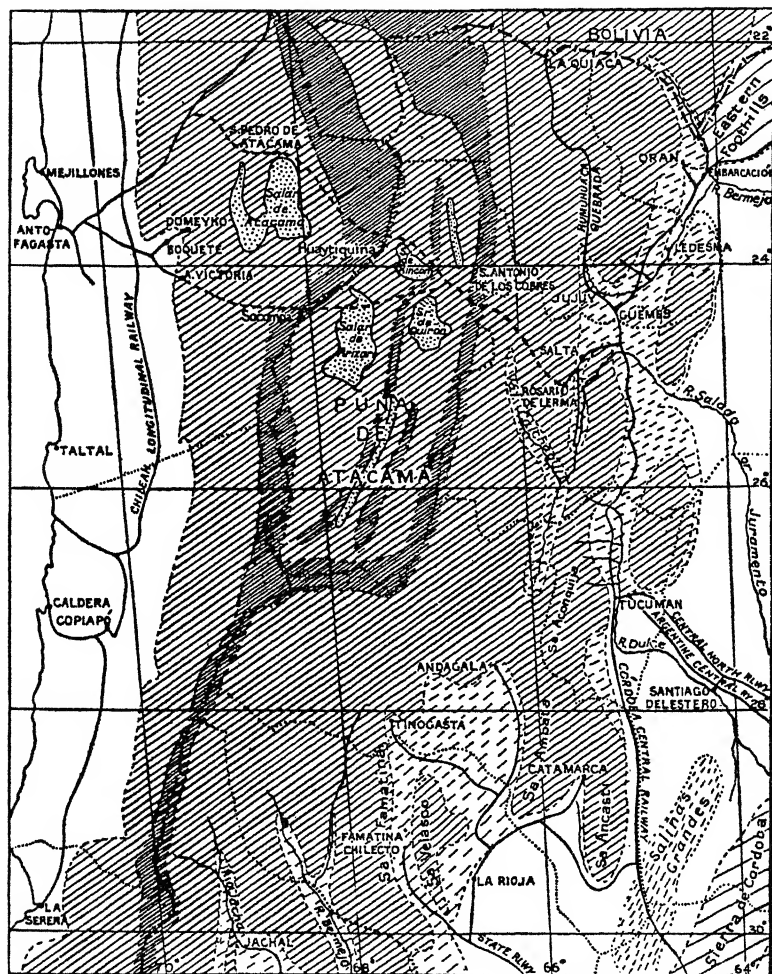


FIG. 32.—North-Western Argentina and the adjoining area of Chile

The main cordilleran chains are shown in dark shading, the broad Andean zone in lighter shading, and the high valley region of Argentina in broken ruling. The broken lines indicate the earlier proposed routes of the Trans-Puna railway, now completed via Socompa. The dotted lines represent the boundaries of provinces and territories.

pre-cordilleran region passes gradually by this transition zone into that of the Yungas, which represent a southern continuation of the Peruvian Montaña.

The heart of the northern sub-Andine zone lies in the valleys of Salta and Jujuy, from which a number of natural routes open out. A gap between the Sierra de Lumbre and other mountains to the south-west leads to Tucumán and the Pampa. The Gunchipas quebrada,¹ almost due south from Salta, affords communication with the Calchaqui Valley, which, by means of its lateral and its head quebradas, provides routes on to the high Puna and thence into Chile. The Humahuaca quebrada in Jujuy leads north to the plateau of Bolivia, has for centuries been an important highway, and is a no less important one now that it is followed by the main state railway (cf. p. 58). From Salta the valley of the Rio Grande de Jujuy, a headstream of the Bermejo, provides easy access to the western Chaco via Embarcación.

South of the Pampa ranges in Córdoba and San Luis the pre-cordilleran zone is narrow. A few minor ranges strike out as spurs from the Andes, and there is a belt of foothills some 70 or 80 miles in width, but more than half of the zone between the Pampa and the Andes is occupied by sandy or saline steppes, which gradually rise in elevation towards the south till between the Colorado and the Neuquen Rivers they definitely pass into the plateaus of Patagonia.

The geology of the whole region between the eastern plains and the Andes is as complex as its relief. From Mendoza southwards the surface layers consist of sand and coarser alluvial material on the lowlands and chiefly of Palæozoic to Cretaceous rocks on the eastern slopes of the Andes. Huge volcanoes such as Aconcagua and Tupingato, now extinct, have ejected great piles of ashes, scoria and lava at various points on these slopes; and where streams issue from their mountain valleys they have usually built up extensive detrital fans, of which that upon which the town of Mendoza is built is a good illustration (Fig. 34).

In the broader part of the zone between 33° and 27° S. two structurally distinct regions have to be recognized. The outlying Pampa ranges and the three related sierras east of the Sierra de Famatina are composed of very old rocks (slates, granites and schists) belonging to the pre-Cambrian and early Palæozoic periods. These are overlaid in places by later sedimentary deposits which rest discordantly upon the basal series.

¹ The peculiar physiographical features of the pre-cordilleran region have given rise to a number of special geographical terms: a quebrada is a deep, ravine-like valley usually dry but occupied by a torrent when rains fall; a valle is a broad deep valley between the sierras in which the stream is more or less permanent and which has a natural outlet; a bolsón is a similar deep valley often completely enclosed towards the lower end, and from which accordingly the drainage, if it can escape at all, can do so only by seepage.

The Sierra de Famatina, though detached throughout the greater part of its length from the western mountains, marks the eastern rim of the Puna region with which, through its prolongation in the Sierra de Gulumpaja, it becomes continuous between 27° and 28° S. The bolsón of Fiambalá, just east of the Sierra de Famatina, thus marks the boundary between the mountains that belong structurally to the Pampean series, and the pre-cordilleran system represented by the Sierra de Famatina and its northern continuations. The latter consist mainly of folded Palæozoic rocks with abundant recent volcanic ejecta, and are to be distinguished from the younger Western Andes which comprise Mesozoic formations. The great valleys or bolsóns separating the finger-like ranges on the southern fringe of the Andean Plateau are due to tectonic movements of the same kind as those that have given rise to the Calchaqui Valley farther north.

The Sierra de Córdoba and the other ranges belonging to the Pampa group have a more advanced type of topography than the border ranges. Their outline suggests tilting rather than folding and shearing. Their tops are flat or rounded and spurs left standing by the forces of denudation are well developed. Those belonging to the Pre-Cordilleras, on the other hand, bear signs in their steep walls scored with ravines, which only now are beginning to cut back into the plateau, of the comparatively recent elevation of the whole system and of the extensive faulting which took place during the uplift. Though the secondary ranges shared in the great elevation of the Andes that occurred in Tertiary and Pleistocene times, the movements affecting them were not so intense as to change the general arrangement of the topography nor cause a completely new cycle of erosion to develop. For the volcanic outbursts representing the latest phase of the final elevation of the Andes and the Puna took place on a surface that had been modelled to mature forms prior to that elevation and showed the gentlest relief over extensive areas in the upper parts; the volcanoes are thus perched high on the plateau, especially on its eastern and western edges, and are so numerous as to form continuous walls on either side several thousand feet above the floor of the plateau. So recent are these volcanoes that denudation has as yet scarcely touched their outlines.

The climate of the intermediate zone between the fertile plains and the main Andes is on the whole arid. The rainfall is everywhere less than 16 inches, except on the middle slopes of the eastern ranges towards the north, and as it occurs almost entirely in the summer, evaporation is intense and the amount available for run-off very small. No surface streams find their way beyond the eastern border of the plains south of 28° S. The slopes of

the Sierra de Aconquija, however, drain into the Rio Dulce, which manages to proceed some distance beyond the region before it gets lost ; and the ranges in Salta Province provide sufficient water to enable the Juramento and the Bermejo to make their way, as already seen, right across the Chaco.

The most important factor in the rainfall of the region is the more or less permanent low-pressure system over the Chaco. In summer this becomes intense, and easterly winds then bring rain to the eastern slopes of the mountains, the western slopes and the tectonic valleys remaining dry. The outlying ranges thus represent islands of fairly well-watered land in a region otherwise arid. The northern part of the pre-cordilleran belt in Tucumán, Salta and Jujuy receives more rain than the southern, since it is narrower and nearer the region of heavy tropical rains. Above 10,000 to 12,000 feet the surface is too high to receive any rain from the east, and the only moisture deposited on the lofty volcanoes along the Puna wall is brought by occasional winter depressions from the south-west, that is, from the Pacific. The Pampean hinterland between the Sierra de Córdoba and the Rio Colorado gets an uncertain rainfall from the various sources that account for the precipitation on the Pampa and in Uruguay (see p. 158). Its western section lies on the great arid wedge that stretches from Northern Chile into Patagonia, and most of the very scanty rain in that section is due to local atmospheric disturbances. In its eastern parts (in S. Luis and La Pampa) the cultivation of crops, which has been pushed thither beyond the borders of the Pampa proper, is peculiarly liable to suffer from irregularities in the rainfall, none too great at any time there. These districts are on the margin of cultivation owing to the climatic factor, just as are the western parts of Kansas and Nebraska in the United States. Droughts of a disastrous kind are by no means uncommon.

In the pre-cordilleran region irrigation is accordingly of supreme importance to agriculture, and such settlements as exist are all at points where stream water can be used to supplement the rainfall. In the bolsóns and valles the fact that the streams descend from the west, that is, from the slopes facing east, has caused the alluvial cones to advance across the depressions and the settlements to be established along the eastern sides. It is obvious, also, that the pasture lands adjoining these valleys will be situated up the mountains flanking the valleys to the west and will be more valuable in summer than in winter.

The intense daily heating which takes place in the bolsóns among the mountains and in the steppe lands between the mountains and the Pampa, causes strong winds, generally from

a southerly point, to blow from midday till late afternoon, and these winds acting upon the sandy surface are apt to produce live dunes which sometimes become a serious menace to farming. The climatic conditions are less severe from Tucumán northwards, but even there, the long dry season, as on the neighbouring Chaco plains, is quite pronounced, and droughts sometimes occur, which become more serious in their consequences as cultivation spreads to lands that are not so well insured against this type of risk as are those close to the permanent streams.

In a zone extending over some 16 degrees of latitude and containing great differences in elevation, it is obvious that there must be wide variations in the vegetation. Coarse grasses and scrub prevail in the western part of the Pampa and in Mendoza and San Juan. In San Luis an open type of forest begins and extends thence northwards through La Rioja and Catamarca, giving place to the Chaco forest towards the Rio Dulce in Santiago del Estero, but throwing a narrow tongue northwards on the higher mountain slopes as far as Jujuy. Parallel with this tongue lies a strip of sub-tropical forest which begins in patches and narrow bands on the mountain sides about 28° S., and gradually broadening, occupies the lower slopes of the mountains both in Tucumán and Salta. On the east this belt of sub-tropical forest meets the Chaco forest at the base of the mountains, but northwards it extends as high mountain (temperate) forest beyond the frontier into Bolivia, and eventually links up with the great forested areas of the Madeira and Amazon Basins (Fig. 12). In Salta the woodland belt on the mountain sides rises to an elevation of 4,500 to 6,000 feet, above which there is a thin cover of vegetation gradually giving place to scattered bunches of ichu grass. The dry forest above mentioned is of the open kind and often broken by bare saline and rocky areas of greater or less extent. The best trees are naturally found along the streams, especially in the southern and western portions of the forest zone. Except in these moister valleys where willows are common and often attain a large size, the trees are generally stunted and consist predominantly of leguminous species, such as algarrobo, which is also found west of the Andes in Central and even Northern Chile. Though this forest furnishes very little timber for external consumption, it is of great importance to the local population, which has to rely upon it for fuel and for wood for general purposes.

The sub-tropical forest belt of Northern Argentina owes its existence to the combination of heat and moisture, the latter being intercepted by the front ranges of the mountains. This forest resembles the luxuriant growths common in the humid tropical

parts of the continent and contains a number of valuable species, among which are cedar and various other useful timber trees. The limited extent of the forest, its mixed character, and the difficulty of access to it in many places, prevent the establishment of any extensive timber-cutting industry in it. Thus the Pampa has, with the exception of the small supplies from the as yet somewhat inaccessible forests in Misiones, and from the limited beech forests of Southern Tierra del Fuego to look beyond the frontiers of Argentina for almost all its supplies of timber for ordinary building purposes.

Of the industries of the entire belt in Argentina between the plains and the Andes, two, namely stock-rearing and agriculture, have been in existence for centuries and largely monopolize attention at the present day. The third industry, mining, has never assumed the place of importance it has occupied throughout the Andes as a whole, and is now neglected except in one or two favoured spots.

The rearing of cattle, horses and mules in the eastern sub-Andine zone was favoured in the early days by the heavy demand for these animals in the mining districts of the Andes, a demand which the western arid districts along the Pacific could not supply. The fodder for the animals was obtained partly from the open pastures in the scrub lands and on the mountain slopes and partly from the rich lucerne fields and meadows in the floors of the valleys and bolsóns. The latter also served as fattening and re-conditioning centres for stock that had been brought in from the Pampa on their way to the mining districts. Towns such as Salta and Tinogasta arose at points where irrigated pastures were abundant and whence stock could be dispatched by the least troublesome routes into Northern Chile and the plateau regions of Bolivia and Peru.

Organized on these lines, stock-rearing is still flourishing at the present time. Large numbers of cattle and mules in particular are annually moved from the border towns in the eastern valleys by various routes : across the Andes south of the Puna in the direction of Copiapó, across the arid Puna to the nitrate fields, and up the Humahuaca quebrada to Huari and other centres in Bolivia. The state railways, now completed on the two latter routes, will stimulate the traffic and lend additional importance to the towns of Salta and Jujuy. On the other hand, the lines already constructed across the Pampa to various points in the intermediate zone have had the reverse effect ; they have diminished the trade of the border towns by drawing cattle away from them south-east and east to Buenos Aires, and several of them, such as Tinogasta and Fiambalá, show signs

of decay. The steppe lands on the borders of the Pampa long remained tributary to these centres, since their only industry was a nomadic type of stock-rearing and their only markets lay to the west. In times of drought, in fact, they were dependent upon the irrigated valleys for pastures for their herds. Now, however,

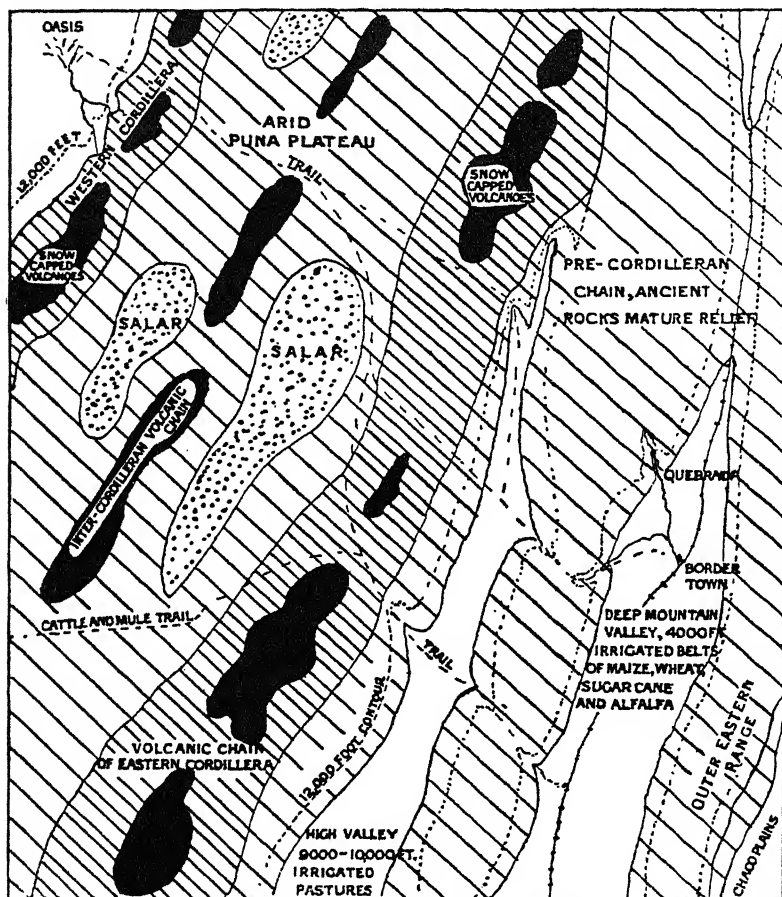


FIG. 33.—Regional Diagram of North-Western Argentina and the Puna de Atacama

all that is changed. The pastoralists of the steppes tend to make better provision against droughts on their own account, and they look to the frigorificos and saladeros of the River Plate as the best markets for their stock.

With the development of the international market at Buenos

Aires another form of stock-rearing has become established in the drier uplands of the north-west. There are nearly 5 million goats in Argentina and the majority of them are reared in that part of the country. This Argentine goat-rearing industry resembles that of North-Eastern Brazil inasmuch as by far the most important product is the skins, valuable enough in proportion to weight to stand transportation from the remote mountain pastures to the towns in the valleys whence they are forwarded by rail.

Apart from the cultivation of lucerne, which belongs rather to the pastoral industry, agriculture throughout the region is concerned primarily with the growing of wheat and maize, but two specialized products, namely sugar and wine, are grown on a relatively large scale in favoured places.

The warmer and wetter parts of the sub-andine zone, with their predominant summer rainfall, provide all the conditions required for the cultivation of maize, while the moderately dry areas throughout the region from Salta to La Pampa Territory, provided the water table is not too low, are suited to wheat. Before the construction of railways and the development of cheap transport by sea, the cereals grown in the north-western valleys found a market, together with the live stock, in the mining districts of the Andes, but these are now more readily supplied by way of the Pacific ports. With the new orientation of the whole region towards Buenos Aires, the cultivation of cereals in the region tends to be limited more or less simply to local requirements, since the suitable areas are too distant and too scattered to share in the great grain trade of the Pampa. However, the local requirements have increased considerably during the last fifty years owing to the rise of the sugar- and of the wine-growing industries, both of them in response to the expanding domestic demand of Argentina as a whole.

The sugar-producing areas are situated in Tucumán and Jujuy with a small north-eastward extension in Salta towards the Bolivian frontier. In the provinces of Tucumán and Jujuy the industries are centred round towns bearing the same names as the provinces and owing their origin to the fact that their sites offered convenient re-conditioning places for cattle and mules on the long journey to Peru.

Situated at the foot of eastern outliers of the Andes these sugar-growing centres enjoy a moderate seasonal rainfall, and in addition derive supplies of water from the streams that descend the mountains just west of them. The rainfall at Tucumán averages about 39 inches a year, and this, though ample for pastures, is insufficient for sugar-cane, nor does it alone provide

enough moisture throughout the year to make possible the maximum yield of maize, lucerne, and similar cultivations by successive cropping which the warm climatic conditions otherwise allow. Thus the waters coming down the slopes of the Aconquija Sierra, and originating in part from the melting of snows above, constitute an invaluable asset for the intensively cultivated lower levels, and the extension of the sugar-growing districts is limited to the area within which irrigation water is available. The Tucumán region is in a peculiar transition zone: the great forests of the Eastern Andes reach their southern limit on the slopes of Aconquija, and similarly the eastern limit of the frost-free zone of the central lowlands of South America lies not many miles away from the foot of that range; not far to the south begin the dry steppes of the Pampa hinterland, while to the north-east lies the Chaco area of mixed sub-tropical forests and marshes. The general evenness of the temperature in this district is one of the factors that have contributed to the establishment of sugar cultivation, though frosts and even droughts occasionally do great damage to the plantations. Tucumán lies, in fact, at the extreme southern limit of the zone in which sugar-cane can be grown in South America, and its chief industry pays the penalty of climatic situation in the form of fluctuations in the yield and of general insecurity. Were it not for the heavy demand of the Argentine market and the protection afforded by high import duties on sugar, it is most unlikely that the sugar-growing industry of Tucumán would have reached its present dimensions; it produced about 70 per cent. of the average of 744,000 tons of sugar from all the Argentine fields in the years 1954-55.

The Jujuy-Salta area offers several contrasts with that of Tucumán. It lies some 200 miles farther north and is thus secure from frosts in spite of its elevation of several thousand feet above the sea. Instead of being situated on the open eastern slope of a snowclad range, it is concentrated at the points where deep sub-andine valleys first debouch on the lower levels, and occupies alluvial tracts watered by the streams that have deposited the latter. The advantages of this situation are counteracted by the restricted area of the suitable land available between the steep mountains on either side, so that the production of sugar is small—only about one-third of that of Tucumán Province. More recently the cultivation of sugar-cane has been spreading north-eastwards along the foothills in Salta between Guêmes and Orán, and more than one authority is of the opinion that eventually there will be an important sugar-growing belt on the lower Andes and in the Western Chaco from the upper Bermejo to the upper Mamoré. Not much development is likely in this

direction in Bolivia, however, until railways have been built across the Eastern Andes, so as to connect the lowlands with the plateau.

In these sugar-producing areas of North-West Argentina the industry is well organized owing in some measure to the concentration of the fields in comparatively small areas. In Tucumán

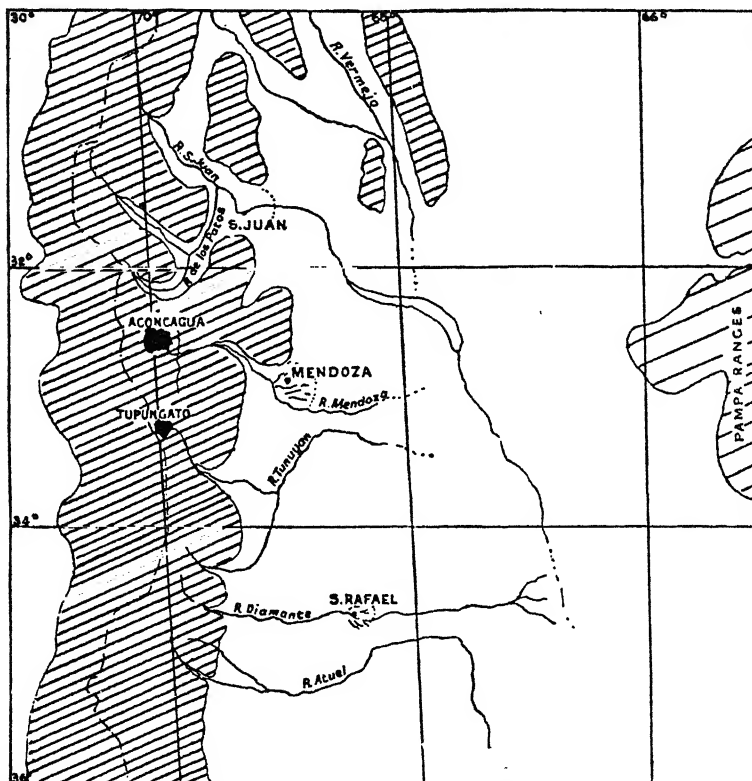


FIG. 34.—The Wine-producing Irrigation Centres of Western Argentina
The broken line traversing the Andes from north to south is the frontier.

two main classes are engaged, the cañeros who grow cane, and the ingenieros who also grow cane and purchase the raw product from the former, and extract the sugar. In Salta and Jujuy the industry is worked in large estates which have their own equipment for extraction. As to the future, it is doubtful whether any great expansion is possible in the output from these districts apart from possible developments north-east towards the Chaco. The areas of land suitable in climate and fertility are strictly

limited ; the yield of sugar from the cane is already low and will be still lower if cultivation is extended on to less favourable lands ; and sooner or later it will be necessary to use fertilizers brought from a distance in order to maintain the fertility of the areas that have long been cultivated under this somewhat exhausting crop.

The wine-producing industry, like that of sugar-cultivation, has been established on irrigated tracts at the foot of the Andes which in the early days were important cattle-fattening centres. Unlike the sugar-cane, however, the grape-vine finds its most congenial conditions south of the zone of combined summer heat and rains. Roughly speaking, therefore, the northern limit of vine-cultivation lies along the line marking off the southern limit of maize-cultivation. Three oasis centres, Mendoza, S. Juan, and S. Rafael, all situated on cones of dejection, are of outstanding importance in the production of wine in Argentina. All of them are at points where rivers (the Mendoza, the S. Juan, and the Diamante) emerge from the mountains to begin their short courses eastward across the plains in which they soon lose themselves. Mendoza not only produces far more wine than either of the others, but has recently developed a fruit-growing industry in table grapes, peaches and other specialized directions, both for the Buenos Aires market and for export (in the northern winter) to North America.

There has been a steady increase for many years past in the output of wine from these piedmont oases, owing partly to their suitability to the grape-vine, though they are unable to produce choice wines, and partly, perhaps in the main, to the rapidly expanding and highly protected domestic market. At all events Mendoza has escaped the crises and the marked fluctuations in yield that have been the lot of Tucumán, and seems likely to make further marked progress both as a wine- and as a fruit-producing district in the near future.

These wine-producing districts of Western Argentina are exceptional among those of the world at large, in that they are situated in a region which is not Mediterranean in climate but which, on the contrary, gets its small rainfall almost entirely in the summer months. The moisture required by the vines and the fruit trees is obtained by means of irrigation which accordingly assumes a place of outstanding importance in the economic life of the settlements ; and the supply of water is subject to careful regulation both by long-established customary rules and by Government authority. The wine industry is highly organized, especially at Mendoza, where there is a fairly clear distinction between the growers of the grapes and the "bodegueros" who

own large vaults and have special facilities for fermenting the grape-juice, and for maturing and storing the wine.

Almost all the mining areas in Argentina are situated in the western and north-western districts, but though the deposits there are moderately extensive, production is very small at the present time. The formations of the Pampa ranges were widely intruded by igneous matter in the Tertiary period, particularly in the southern area in S. Luis, and various minerals, including lead and tungsten, are associated with these intrusions. The western area occupied by the pre-cordilleran ranges shows mineralization similar to that of the main Andes to the west and the north. At one time silver was mined on a large scale, but early in this century attention was confined to the auriferous and argentiferous copper ores in La Rioja and Catamarca, the widespread lead ores not being profitable to work. Situated at extremely high elevations, the mining centres there were never very prosperous, and little mining is now carried on in Argentina outside Jujuy province, where some lead, zinc, silver, and tin are produced by an active modern corporation. Argentina, like Uruguay, is poorly endowed with mineral resources compared with most other South American countries.

The fact of the matter is that although minerals of various kinds are widespread in the north-western region, no very rich deposits have hitherto been discovered such as in the western Andes ; and in view of the long haul to the sea and the acute shortage of labour in Argentina owing to the demands made by the pastoral, agricultural and manufacturing industries, the preliminary requisite for a successful mining industry is the discovery of deposits that can compare with those elsewhere in South America in extent and concentration.

Petroleum has been discovered in two distinct fields in the sub-andine region. One lies in a long narrow belt from the neighbourhood of Mendoza town to beyond the upper Neuquen, but the wells there have so far proved to be short-lived and the total yield of oil small. The other begins somewhat south of Salta and extends thence north-east along the valley of the Rio Grande de Jujuy past the upper Bermejo and across into Bolivia. The topography of this region is very complicated and the strata are exceedingly folded and faulted so that the deposits must be discontinuous. Nevertheless, it is thought that the northern field is a promising one, more especially towards and beyond the Bolivian frontier ; as a branch of the state railway from Perico on the main line, following the main axis of the field, has already been pushed beyond Embarcación to Yacuiba, and another line has been built to it from Formosa, there will in time be

sufficient transport facilities. The sinking of trial wells is now in active progress in the Bolivian section, but the preliminary work is far from easy because of the dense forest cover and the difficulty in maintaining transportation. The yield of petroleum from the whole northern area has so far not amounted to much, but should it develop as is hoped, it will prove to be of immense benefit not only to the sub-andine zone, but also, and more especially, to the plateau region of Bolivia and the adjacent high-lying mining districts of Chile, both of which suffer from the scarcity and high cost of fuel at the present time. (See p. 199.)

With regard to communication, the whole region from La Quiaca and Orán, close to the Bolivian frontier, to Zapala and Neuquen in Northern Patagonia has been brought within reach of Buenos Aires by means of railways. The only part of it, on the eastern border of which lines from Buenos Aires and the Pampa stop short, is the arid steppe and foothill district between 35° and 38° S. S. Rafael on the Diamante and Colonia Alvear on the Atuel each now have separate direct connections with Buenos Aires in addition to that with Mendoza; and S. Juan can be reached not only from the latter centre but also direct from Córdoba by a railway that throws branches northwards into the succession of great valleys in La Rioja and Catamarca, bringing the old-time towns of Catamarca, Andalgalá, Rioja, Tinogasta and Famatina into touch with the busy commercial life of the Pampa. The Córdoba Central runs north from Córdoba over the outlying range and across the Salinas Grandes to Tucumán, which is linked with the Pampa also by the Central Argentine and by the State Railway known as the Central Norte. The latter continues by a route through the first line of mountain valleys on to Salta, Jujuy and the Bolivian frontier, with an important branch to Orán on the Bermejo, beyond which it has been completed to Yacuiba and thence into Bolivia.

Hitherto the effect of the railways has been to dissolve the connections which the sub-andine region had formed under its own independent initiative with the non-Argentine districts towards the Pacific and on the Plateau. But the link with the Bolivian Plateau railways, completed in 1926, will sooner or later lead to the re-establishment on a more active scale than ever of the trade relations between the north-western Argentine provinces and the mining districts beyond.

Mention has already been made (see p. 58) of the now-completed railway across the Puna region into Chile. This is one of the most ambitious enterprises of its kind in the world, the completion of which became possible when Argentina grew prosperous in the second Great War. The section between Salta

and Rosario de Lerma was difficult enough, but that west of the latter place consists of tunnels, embankments and bridges, beyond which the route adopted leads up the Eastern Cordillera by the Chorillos Pass, 14,655 feet above the sea, and then for upwards of 200 miles across the Puna at an average elevation of 12,000 feet, and across two further high ranges on it. From a point north of the Salar de Quiron, the railway passes south of the Salar de Atacama via Socompo Pass to Augusta Victoria, the former terminus of the line from Aguas Blancas. The desolate nature of the region traversed on the plateau can be gathered from the fact that the whole population of the former Argentine Territory of Los Andes is no more than 3,000 persons, all Indians and living in the valleys of the eastern rim of the Puna. The railway simply unites two economically complementary regions across one of the most inhospitable zones in the world outside the Polar regions.

CHAPTER XVII

THE PATAGONIAN PLATEAU, TIERRA DEL FUEGO AND THE FALKLAND ISLANDS

THE Rio Colorado marks the general boundary between the Pampa plains and the Patagonian Plateau, which comprises the four Provinces (formerly Territories) of Neuquen, Rio Negro, Chubut, and Santa Cruz (re-named Patagonia), and the Territory of Tierra del Fuego. Within the geographical area to which these belong lies the south-eastern part of the Chilean Territory of Magellanes which, like the other divisions above mentioned, slopes towards the east. Except along the Atlantic coast, in the extreme southern section, and in certain valleys elsewhere, the whole area consists of a plateau extremely irregular in surface, more or less devoid of water east of the line of glacial lakes in the Andes, windswept, treeless, and carrying a very scanty population.

Structurally and physically, however, the Patagonian region contains a number of interesting features. In the eastern zone the elevation is only moderate, but terraces along the coast and hills and mesas at no great distance inland indicate that there is no true coastal plain, except along the mouths of the larger streams to the north. Already near the sea the formations consist of horizontal sedimentary beds overlying a crystalline base both of which continue westwards across the plateau. Beyond the belt of terraces and platforms of intermediate elevation there extends throughout the breadth of the region to the pre-cordilleran trough, and throughout its length from the Rio Negro to the Straits of Magellan, a series of plateaus averaging from 1,000 to 3,000 feet in height, but in places exceeding 5,000 feet. The surface of these is covered in places with river and glacial debris brought from the Andes, in places with more or less recent lava sheets ; but is free elsewhere of these adventitious materials, so that the sedimentary and even the granitic rocks and the products of their decomposition occasionally form the uppermost stratum.

Some distance away from the Andes the plateau formations stop short and where exposed stand as a wall facing those moun-

tains. The space between the folded Andes to the west and the horizontal strata of the plateau is occupied by the sub-andine depression or pre-cordilleran trough, which is recognizable from Lake Nahuel Huapi (41° S.) to the Straits of Magellan. In some places, in particular in Santa Cruz, it is blocked up by volcanic materials, in others, especially in Chubut, it is filled with glacial detritus. Thus the drainage from the Andes is able at various points to make its way across the zone of the structural depression and escape to the Atlantic, but head and tributary streams frequently flow more or less south or north for some distance before finding exits through the eastern rim of the plateau; though part of the drainage is carried west across the Andes to the Pacific by rivers that have cut their heads back eastwards, and whose

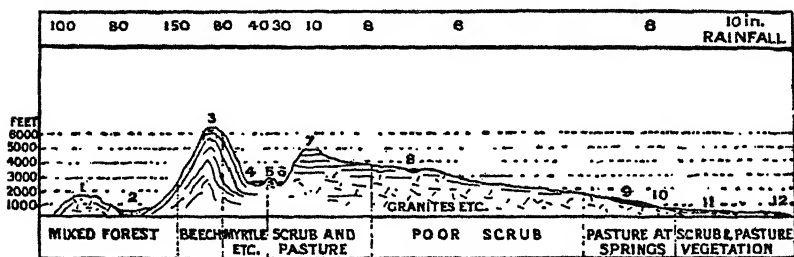


FIG. 35.—Diagrammatic section across South America in about Latitude 41° S.

KEY TO STRUCTURAL FEATURES.

1. Coastal Range (folded ancient rocks). 2. Longitudinal Valley (recent sediments). 3. Andes (folded Mesozoic rocks). 4. Lake Nahuel Huapi. 5. Moraines, etc. 6. River Limay. 7. Western edge of Patagonian Plateau. 8. Lake Carlaufquen. 9. Lava sheet. 10. Colonia Valcheta. 11. Coastal Plain (Tertiary sediments). 12. Port S. Antonio.

Horizontal scale: 1 inch = 125 miles.

Vertical scale: 1 inch = 13,700 feet = 48 times horizontal.

valleys are occupied in part by the glacial lakes that lie athwart the mountains.

These three longitudinal zones, the coastal, the plateau and the trough, are well marked south of 41° S., but northwards from that, the third of these zones drops out and its place is taken by a pre-cordilleran mountain and valley zone somewhat resembling that of North-Western Argentina: in it the plateau formations abut against the outer ranges of the Andes and behind there are valleys such as that followed by the Alumine River. Towards the Atlantic the northern section of the Patagonian Plateau is marked by a series of deep depressions, now practically dry, such as the Bajos of Gaulichu and Valcheta. The origin of these depressions remains doubtful. It appears, however, that they do not represent old river valleys, as has been supposed.

The surface features of Patagonia owe their striking pecu-

liarities to a combination of climatic and structural factors. The low rainfall, nowhere more than 10 inches east of the Andean region, causes the arid type of topography to prevail, and gives the strong westerly winds full scope in moulding the landscape. The bajos or deep enclosed valleys previously mentioned, whatever their primary cause, are thought by some authorities to have been excavated to their present depth, which in some instances is below sea-level, by eolian agencies. Wherever water-borne or glacial material covers the plateau, the winds tend to remove the lighter particles and to leave the surface strewn with rocks, pebble and shingle. Armed with the sandy dust the winds proceed to attack projecting rock surfaces elsewhere and to carve them into a maze of hollows and fantastic shapes. In the depressions and valleys, wherever they occur farther east, the finer material carried in the air is apt to get deposited and intermingled with the saline incrustations that form there. The thin cover of vegetation throughout the central belt of the plateau is powerless to prevent the winds being almost supreme as weathering agents over a very large area.

The surface of the plateau as well as of the sub-andine region is thus very broken. Many of the so-called rivers become dry at certain times, and numerous completely waterless valleys and hollows, together with other widespread features of surface sculpture, point to heavy erosion under arid climatic conditions apparently continuing backwards into the Tertiary period. Nor is the surface much more even where it is covered with recent lavas. Under an arid climate the cracked and jagged upper layers retain their broken form for very long periods: in some parts the lava fields are almost impassable.

The rivers that now cross the Patagonian Plateau from the Andes to the Atlantic, like those of the Brazilian Plateau, are old enough to have cut thoroughly mature valleys. On emerging from the sub-andine zone they occupy deep trenches, usually several miles in width and bounded on each side by the steep wall characteristic of river valleys in dry climates wherever there is a marked fall in the beds of the streams. As the Patagonian rivers approach the Atlantic their volume declines; and with the fall in the elevation of the land surface there is a corresponding fall in the height of the valley walls or barrancas. On the Negro, for example, these stand 600 feet above the valley floor at Neuquen, but gradually sink to less than 100 feet near the sea. The succession of groove-like valleys, among which those of the Negro, the Chubut, the Deseado, the Chico and the Gallegos are the most noteworthy, form a striking feature in the topography of the plateau.

The sub-andine zone, on the other hand, has been moulded on bolder lines mainly by other agents than the winds. Even in that section which lies east of the continental divide, crustal movements have been at work on a grand scale. They are responsible not only for the tectonic trough south of Nahuel Huapi and for the pre-cordilleran valleys in Rio Negro and Neuquen, but also for a series of longitudinal and transverse faults in the Eastern Andes which break the mountain system into a number of separate blocks. Subsequent to the arrangement of the drainage in accordance with the features left by these movements, extensive glaciation intervened, carrying morainic material across the tectonic trough at various places, and causing the formation of deep-set mountain lakes from latitude 39° S. to Tierra del Fuego. The eastern edge of the Patagonian Plateau is often nearly as high as the Andes, which have suffered much more severely from denudation, and the eastward drainage of a number of the Andean lakes is to be ascribed to the fact that at one time the mountain belt was higher than now and outlet gaps were then cut in the plateau by rivers issuing from waters stored in the trough, and more especially from the eastern edge of the ice-sheet when it occupied that depression.

North of Lake Alumine the scenery of the eastern Andean zone is characteristic of that of dry mountain slopes. Vegetation is very sparse. Many of the streams flow only intermittently, and those that carry water to the plains deposit alluvial fans at the exits of their mountain valleys. But with the increasing precipitation southwards, combined with the diminishing height of the Andes, a change comes over the landscape features. The rivers become powerful and permanent, and from the Agrio onwards begin to trench themselves in marked valleys, the upper parts of which are often occupied by glacial lakes. Lake Nahuel Huapi is the first of these that has fiord-like arms walled in by high mountains. Between that lake and the Straits the mountain area assumes almost completely the features of the Scandinavian system: there is a broad belt of mountains rather than a single narrow chain; glaciers appear on the heights at 42° S.; forests cover the less precipitous slopes below the snow-line and alp-like meadows are common in the valleys. There is a somewhat rapid transition across the pre-andine trough from this mountain, fiord and forest type on its western border to the arid wind-sculptured plateau type almost immediately to the east. Except in the Magellan region the Pacific snows and rains penetrate nowhere very far into Argentine territory.

Beyond 51° S. the Andes disappear as a distinct watershed.

They degenerate into a marshy plateau invaded by the sea in Ultima Esperanza Inlet, Skyring Bay and Otway Water, and come to an end at the Straits of Magellan. The Patagonian Plateau sinks by degrees correspondingly. Just north of the Straits it consists of plains of moderate elevation, while in the eastern part of Tierra del Fuego there are wide stretches of lowland sloping gently towards the Atlantic. The Chilean section of this southern continuation of Patagonia contains, it is said, the most extensive area of continuous plain to be found any-

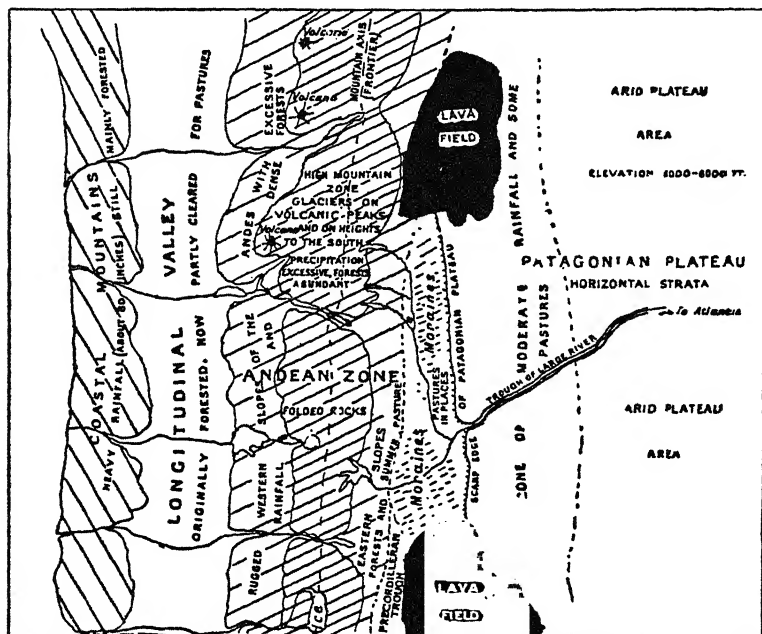


FIG. 36.—Regional Diagram of Andes and adjacent areas in latitude 39° to 41° S.

where in the whole of the Pacific republic. With the change from tableland in Santa Cruz to lowland beyond the Straits of Magellan there is a corresponding change in the soil cover. Glacial detritus and lava fields give place to more ordinary materials in which sandy sediments poor in lime content prevail. The scenery loses the rugged and inhospitable appearance common on the plateaus of Patagonia, and assumes the monotonous features of similar lowlands in North Germany.

The western and southern borders of Tierra del Fuego, representing a continuation of the Chilean Coastal Range, are mountainous and rugged. Where they are exposed to the full force

of the westerlies along the Pacific shore, the uplands have been dissected into a typical fiord coast, corresponding closely in latitude, in the prevailing crystalline structure, in block faulting and in heavy subsequent glaciation to that of Northern Norway. Glaciers still exist which descend right down to sea-level and glacial lakes abound. Beech forests, containing the same species as those found in the fiord region of Western Otago in New Zealand, clothe the eastern slopes and valleys and occur in sheltered places elsewhere.

The Falkland Islands, though apparently differing in geological structure from the mainland areas of South America, resemble the western part of Tierra del Fuego in showing evidence of extensive glaciation. Falkland Sound between the two larger islands and a host of inlets round their shores are all of the deeply incised fiord kind. The surface of these islands is hilly, but is free from striking irregularities; low ridges, more or less devoid of grass or other vegetation, cross the islands at intervals; the lower-lying tracts are intersected by quartzite reefs which project somewhat from the surface and stand out with a whiteness that contrasts sharply with the dark background; here and there hollows occur in which the drainage collects and forms swamps. The constant gales to which the Falkland Islands are subjected, together with other and not yet clearly understood causes, prevent trees from growing anywhere in them except in very sheltered places. Altogether, therefore, the scenery of the islands resembles rather that of the northern moors of the British Isles than that of the South of England which is about the same distance from the Equator.

Two features, namely general aridity and strong winds, dominate the climate throughout the Patagonian region and extend with but slight modification into the lowlands of Tierra del Fuego. Only a small proportion of the whole receives a precipitation exceeding 10 inches by annual average. In the West the isohyet of 10 inches curves gently eastwards from the frontier in Neuquen Territory so as to leave a narrow zone in the sub-andine region with a somewhat higher rainfall. The 20-inch isohyet corresponds with the frontier between 31° S. and 37° S., then leaves a lens-shaped area in Argentine territory between 37° S. and $44\frac{1}{2}^{\circ}$ S. with upwards of 40 inches of rainfall, and another more irregular belt with the same rainfall between 47° S. and the frontier angle at 52° S. The western part of Santa Cruz Territory receives a rainfall ranging from 10 to 30 inches and Punta Arenas about 19. Towards the Atlantic only the extreme eastern part of the Rio Negro and the north-eastern part of Chubut are favoured with more than 10 inches of rain per annum.

The winds that reach the plateaus of Patagonia from the Andes are dry in the main and readily absorb any surface water over which they blow. The few lakes that exist east of the sub-andine zone are therefore liable to get dried up periodically, leaving saline deposits in their beds, which become re-dissolved in part or entirely when the water returns with the succeeding rainy period. Depressions of this type, whether small or large, are known in Patagonia, as in the Chaco, as salitrales. Over wide areas in the central zone from the Colorado to the Gallegos a great deal of the surface water gets collected in these salitrales whose margins are even more unfavourable to vegetation than the surrounding areas of higher ground that drain into them. Nor are salitrales confined to those parts of Patagonia which have no recognizable drainage to the sea, for they are found in some of the broad and deeply trenched river valleys, especially towards the Atlantic.

The small rainfall of most of the Patagonian area comes mainly in the winter and is associated with depressions which travel eastwards from the Pacific. This seasonal concentration favours evaporation during the season when the sun is strongest and accounts in some measure for the general aridity. Towards the south, however, in Southern Santa Cruz and in Tierra del Fuego, there is a tendency to a summer maximum, and the conditions there are accordingly more favourable to pastures than in Rio Negro and in Chubut. In the last two territories fresh water is found only in scattered localities and under special conditions; either in the valleys of the permanent rivers, or in the depressions called mallins which are sufficiently well provided with water to have an outlet, or along the edges of the basaltic lava sheets resting upon impermeable strata, where rain water that has worked through the cracks in the lava finds its outlet. The vegetation in these three more favoured types of situation contrasts by its greenness and variety with the prevailing grey and xerophytic vegetation of the plateaus. In sheltered positions willows and brushwood plants manage to maintain themselves in strips and patches, particularly in Neuquen and in the northern districts of Rio Negro.

There is naturally a fairly close connection between the amount of the rainfall and the distribution of supplies of fresh water. Thus salitrales are the rule wherever the former is less than 200 mm. (8 inches) and give place to mallins in the eastern and western zones where the rainfall is greater. The provision of drinking water for live stock is a difficult matter in a region in which great distances separate the various places where there is permanent fresh water. To some extent supplies

are obtained from the manantiales, or seasonal sheets of water formed by the rains, which differ from the salitrales in that they do not contain drainage water charged with matter in solution, and do not therefore leave saline deposits on drying up. Elsewhere wells have been sunk both in the sand dunes and dry valleys of the northern districts and in the lava flows common in certain parts of the western and southern sections. Nevertheless the Patagonian Plateau as a whole remains largely an arid wilderness. Here and there natural oases occur, and these are being slowly added to by a few others due to man's efforts. The fact remains that neither the rainfall that manages to pass the sentinels of the Andes nor the great reservoirs of water in the glacial lakes in those mountains can ever be sufficient, however utilized, to redeem Patagonia from the age-long sterility which has been its fate.

In spite of the general aridity of the plateau, the soils, where they consist of finer particles such as sandy clays and loess-like earth, carry in addition to scrub plants a kind of tussock grass which is nourishing enough to support sheep and in some places even cattle. In the river valleys and in the mallins, of course, the grasses are more succulent and luxurious, and along the courses of the Negro and Chubut limited cultivations, in particular of lucerne, cereals and vines, are possible. In order to increase the area of these, the Argentine Government has undertaken the construction of irrigation works in the valleys of the Rio Negro and of its headstreams the Neuquen and the Limay, where it is estimated that upwards of a million acres are capable of being improved by such means. The area so far irrigated amounts to 130,000 acres, a small affair compared with the million and a half acres under irrigation in Mendoza Province, but as both the Southern Railway and the Federal Government seem prepared to further these works, increases in the area of irrigated lands and consequently in that of cultivations are to be expected in Northern Patagonia in the near future. Perhaps the greatest drawback from which the valleys of the Rio Negro system and also of the Chubut suffer is the liability to floods arising from exceptionally heavy precipitation on the Andes. Neither the Neuquen headstream of the Negro nor the upper Chubut take their rise in large Andean lakes that elsewhere serve as storage reservoirs. Consequently the irrigation works have to be so planned as to serve the double purpose of storing water for gradual release, and of saving the lower parts of the valleys from disastrous floods. There can be no question of utilizing the water from the rivers to irrigate the adjoining high-lying plateau in Northern Patagonia, but much can be done by cutting side

channels to divert surplus water from the rivers for storage or for irrigation purposes to parts of the relatively broad valley floors that are at present arid.

Irrigation works, in the form of side channels to the main rivers, might also be introduced on a considerable scale in the valleys of the rivers that traverse Patagonia south of the Chubut ; but for two reasons expenditure in this direction is not likely to be incurred at present ; the lakes in which the rivers take their rise become larger and more numerous towards the south, so that the flow of the rivers is fairly even ; and the severity of the climate prohibits the cultivation of other than hardy fodder crops, which seem superfluous in a thinly settled area of fairly abundant natural pastures.

The most promising part of Patagonia appears to be that of the pre-cordilleran trough and the eastern slopes of the Andes. From Lake Nahuel Huapi southwards the mountain zone is forested, first with trees in which *Araucaria imbricata* is prominent, and towards the Straits with hardier types such as beeches. So much of this forest area, however, is inaccessible that no important timber industry is likely to be established in this part of Argentina. In fact, the settlers regard the trees as a nuisance, and destroy them as quickly as possible. The real wealth of the region lies in its pastures, actual and potential. Meadows are abundant both in the river valleys and in the sub-alpine uplands in the neighbourhood of the lakes. Water is to be had in plenty, and the climate is not too severe. At all events sheltered places are always to be found on the lower levels during the winter. Taken as a whole, the sub-andine zone, though somewhat cold for crops owing to its elevation, is well suited to cattle, and may become more fully settled with pastoralists with the construction into it of railways from the eastern ports, if only Southern Argentina can find sufficient Argentine herdsmen to leave their natural home on the open plains for enclosed mountain valleys. The settlement of the valleys in the north-west from San Juan to Salta is not a parallel case, for it took place before the Argentine became essentially a man of the plains.

The population of Patagonia and Tierra del Fuego is still very sparse. There are fewer than 450,000 inhabitants east of the Andes in the whole region south of the Rio Colorado, and of these the greater proportion are settled in the basin of the Rio Negro and in Santa Cruz. Chilean and Argentine Tierra del Fuego both contain very small numbers indeed, while in Chubut there are only three widely separated districts that can claim anything more than an exceedingly thin semi-nomad pastoral population. These are the Welsh settlement at the

mouth of the Chubut River, its offshoot in the Andean zone at Diez y Seis de Octubre, and the Rivadavia petroleum field.

The European settlement of the Patagonian Plateau from the Rio Negro to the Straits has taken place in quite recent times, for the Indians remained masters of the region until they were subdued shortly after 1880 by Rocas and Ortigas. Prior to that time there had been an important Indian trading centre at Choel Choel Island on the middle Negro, where horses and cattle, either purchased or stolen from the Southern Pampa, were collected for sale to Chile. In the late nineteenth century the sub-andine region between 35° and 40° S. was occupied mainly by Chilean pastoralists who used the routes westwards over the mountains as their outlets, and Chos Malal on the upper Neuquen was a relatively important local centre for cattle traffic. With the delimitation of the frontier many of the Chileans have withdrawn and their place has been taken by Argentine settlers working south from Mendoza. The construction of the railway from Bahia Blanca, first to Neuquen, occupying an important position at the confluence of the Neuquen and the Limay, and later to Zapala on the edge of a lava-covered meseta adjoining the Pre-Cordilleras, has brought this part of the sub-andine region within reach of the freezing works on the Atlantic coast, and has detached it completely for the time being from its erstwhile economic orientation towards the west.

The advance guard of settlement in all the rest of Patagonia as in Tierra del Fuego has consisted of sheep-farmers, and sheep represent at the present time far the most important item of wealth—in most places the sole item. The occupation of the region has proceeded from three different directions: down the Atlantic coast from Bahia Blanca along the zone of somewhat higher rainfall; up the river valleys from various separate points at their mouths, such as Rawson on the Chubut, Puerto Deseado on the Deseado, Santa Cruz on the Shehuen, and Puerto Gallegos on the Gallegos; and finally up the sub-andine zone from the Magellan region.

In no comparable area in the world is the proportion of sheep to the population so high as in Patagonia and Tierra del Fuego. Argentine Patagonia contains some 17 millions of these animals and the Chilean Province of Magallanes over $2\frac{1}{2}$ millions, or about $19\frac{1}{2}$ millions in all, that is about 45 sheep per inhabitant. In the Argentine section of Tierra del Fuego the proportion reaches its extreme with over 265 sheep per inhabitant. What is true of the mainland also applies to the Falkland Islands, where scarcely any crops can be grown, where cattle and horses are scarce, and where almost all of the available resources are

turned over to sheep, which number 600,000 against a population of 2,250, i.e. about 266 per inhabitant.

The sheep-rearing industry was assisted in its initial stages by the comparative ease with which the main product, wool, could be transported from inland points to the coast, and merinos were favoured, not only because of the high value of their fleeces but also because they are easier to look after in a wild region owing to their habit of working over the pastures in close formation. The establishment of freezing works at Punta Arenas, Gallegos, S. Julian, and Deseado, in addition to those at S. Antonio and Bahia Blanca, together with the construction of railways from these points eastwards across the plateau, has led to concentration upon mutton as well as wool and to the partial substitution of merinos by crossbreds just as happened earlier on the Pampa. In the Falkland Islands, on the other hand, wool remains the chief product, surplus sheep being dispatched alive to the mainland.

So important are the railways in the opening up of Patagonia that the Argentine Government is pushing construction as a means of encouraging settlement. The broad-gauge line from Bahia Blanca into the Neuquen Territory has already been mentioned. This was worked by the Buenos Aires and Southern under a Government guarantee. From S. Antonio a broad-gauge railway, 657 miles in length, has been constructed over the plateau via the eastern end of the Bajo de Valcheta and Maquinchao to Bariloche on Lake Nahuel Huapi, whence in due course a connection will be made up the Alumine Valley with the future trans-continental railway which has now reached Zapala. In this way the at present isolated settlements of Junin de los Andes and San Martin de los Andes will be connected with the outside world. Other trans-Patagonian railways, in course of construction from Comodoro Rivadavia and Puerto Deseado, have reached points inland distant 130 miles and 178 miles respectively from the coast.

As time goes on, the exclusive attention to sheep-rearing which has so far characterized the development of Patagonia will no doubt be modified in certain directions, in particular by an increase of cattle-farming in the sub-andine region. The discovery of petroleum at Rivadavia on the Gulf of St. George has given rise to a localized industry which may expand for some time to come as it has done in recent years.¹ The Government

¹ The output from this field rose from less than 200,000 tons in 1919 to an average of some 2½ million tons in 1940-46 and to over 3½ million tons in 1956. A pipe-line now conveys natural gas from this field to Buenos Aires via Bahia Blanca, a distance of about 1,000 miles.

geologist, however, believes that the field is restricted to the region between the Gulf of St. George and Lake Musters, a comparatively small area compared with that of the great petroleum areas in North America. The Mendoza petroleum field, mentioned in the previous chapter, extends in a broadening band into Neuquen Territory as far as Lake Nahuel Huapi, but very little oil has so far been produced in the Patagonian section of this zone.

With regard to the timber industry, though the forests in pre-andine Patagonia are and will remain difficult of exploitation, the same does not apply to those in the southern part of Tierra del Fuego. There cutting is in active progress for the Buenos Aires market, the timber being shipped from the port of Ushuaia on the Beagle Channel.

The future of Patagonia and of its outlying parts is in one way assured. Just as sheep have been driven from the Pampa to make room for cattle and cereals, so they are losing ground in other parts of the world where they formerly held sway. The result has already appeared in a hardening of prices for wool and other sheep products, and the continuance of this situation will mean good fortune for such essentially sheep-farming regions as Patagonia, however indifferent in carrying capacity they may be.

CHAPTER XVIII

THE ANDES

A PART from the distinct system in the Coastal Range, the Andes rank as one of the greatest mountain ranges of the world, in view of their high average elevation, their great length and the large area they cover. By reason of the Andes alone, South America contains a greater proportion of land over 10,000 feet in elevation than does any other continent. From about 51° S. to 10° N. those mountains form a continuous barrier, which not only effectually divides the drainage of the continent into two systems, a narrow western one and a broad eastern one, but also makes communication between the two drainage areas exceedingly difficult. Only one railway had till 1926 been built across the chain, and that at a point where an ascent to nearly 11,000 feet above the sea is necessary; while another, the recently completed link between the Argentine lines and the Antofagasta and Bolivia Railway, rises to over 14,000 feet.¹

Though the Andes present a varied cross-section structure with a succession of distinct ranges and intervening valleys and plateaus throughout the greater part of their length, weathering agents have with some exceptions contributed little to their present configuration, less than they have in most other great mountain systems of the world. The recent and apparently rapid uplift of the Andes, the still more recent ejection of vast masses of volcanic material, together with the formation of serried lines of volcanoes, the marked aridity of the western slopes for nearly two-thirds of their total extension north and south, and the fact that, before warm humid air rising from the interior lowlands of the continent reaches the upper Andes, it has parted with almost all its moisture, are all factors that have kept the forces of denudation at a minimum of activity.

¹ Various other railways have, of course, been built into the Andean region from the Pacific coast, but the heights to which they have to ascend simply emphasize the seriousness of the mountain barrier. Thus the Guayaquil and Quito rises to 11,841 feet, the Central Peruvian to 15,665 feet, the Southern Peruvian to 14,688 feet and the Arica-La Paz to nearly 14,000 feet.

The succession of lofty chains, high plateaus and deep valleys that characterizes east and west cross-sections of most of the Andes, is to be ascribed in the main to crustal movements with subsequent widespread vulcanism. Most of the longitudinal valleys in the well-watered eastern zone within the tropics are primarily due to folding and faulting, though they have been much deepened and extended by river erosion. Similarly also the great valleys between the cordilleras of the Colombian Andes represent structural depressions which the drainage channels have appropriated and enlarged.

Cross-fractures are uncommon in the Andes from the Caribbean to about 38° S. ; gorges have been cut here and there through the Eastern Cordillera in Peru and Northern Bolivia by rivers, but these are merely notches in the outer edge of the mountain system viewed as a whole ; the central and western chains are but little affected. Between 38° S. and the Straits of Magellan, however, the single broad mountain chain of the Andes resembles a dissected plateau. Extensive faulting has taken place both longitudinally and transversely, and has given weathering agents, in particular glaciers, an opportunity of cutting the chain deeply at numerous points.

Northwards from the latitude of Valparaiso the Andes, which consist of a single chain from their southern limit to that point, begin to broaden out. Firstly, there are the outlying more or less parallel ranges on the eastern side in the Argentine province of S. Juan together with the spurs on the western side which practically fill the Longitudinal Valley of Chile. Secondly, about 32° S. the series of pre-cordilleran ranges already described (see p. 201) makes its appearance on the eastern flank of the main system and continues northwards to about $27\frac{1}{2}^{\circ}$ S., where the inner ranges merge into the eastern cordon of the Puna, and the outer ranges are succeeded by others which extend beyond the Bolivian border.

Where the Puna of Atacama begins on the south, the Andes first assume the broad plateau structure that persists without interruption for upwards of 1,000 miles to the Cerro de Pasco knot in Peru, and which is resumed over considerable stretches north of that as far as Central Colombia. The main features in this plateau zone are the lofty border ranges on either side enclosing between them a high tableland which is by no means regular as to its surface formation. From $27\frac{1}{2}^{\circ}$ S. to the Bolivian frontier the two cordilleran rims of the Puna are lined with volcanoes thrown up during late Tertiary and Pleistocene time, some of which are not yet extinct. East of the Puna rim formed by the Cordillera Real in North-West Argentina lies the labyrinth

of mountain ranges and valleys of the pre-cordilleran zone, while beyond the western edge of the Puna, marked by the Cordillera Occidental, lies an outer line of sierras, including those of Sarapana and Domeyko, in Antofagasta Province. Between the Cordillera Real and the Cordillera Occidental, and again between the latter and the outer chains in Chile, the high plateau consists of a number of enclosed basins whose general alignment is north and south, separated one from another by secondary volcanic chains running lengthwise between, and more or less parallel with, the border chains. Among these inter-cordilleran chains the most prominent is the Sierra de Antofalla which traverses the Puna in latitude 24° to 26° S.

The plateau basins lie at an elevation of 10,000 to 12,000 feet above the sea, but receive little rains or snow themselves owing to the high Eastern Cordillera and, still more, to the pre-cordilleran chains which deprive the easterly winds of practically all their moisture. Some snow, however, brought by occasional storms, is deposited on the lofty volcanoes surrounding the basins, and the water from this source that descends into the depressions, disappears by infiltration and evaporation, leaving large saline areas known as salars. Some of these, such as the Salar of Arizaro and the Salar of Atacama, each cover areas of more than 1,000 square miles of salt-encrusted desert. Towards southern Bolivia the main Western Cordillera becomes one of the grandest series of volcanic peaks in the world and continues as such for some distance along the frontier between Bolivia and Chile. Here there are such lofty mountains as Llullaillaco, Socompa, S. Pedro y S. Pablo, and Ollaguë, with deposits of sulphur on their slopes and of borax in the salars below them. Volcanic peaks constitute, in fact, a prominent feature of the Western Cordillera as far north as Colombia and occur at intervals in the southern Andes down to Lake Nahuel Huapi. Tronador and Aconcagua, El Misti in Peru, and Chimborazo and Pichincha in Ecuador, together with those mentioned above, are simply outstanding examples of the hundreds of volcanoes, active, quiescent or extinct, that overlook the Pacific from the heights of the western Andes.

The Eastern and Western Cordilleras are very distinctly marked throughout the whole north and south extension of Bolivia and beyond as far as the Vilcanota knot in Peru. In this region they enclose a great plateau basin, scarcely any of the drainage of which escapes to the lowlands beyond. In a hollow in the northern part of the plateau basin lies Lake Titicaca, one of the most extensive bodies of fresh water in the world. This lake is at the foot of the high Eastern Cordillera, where the latter first turns north-west and is in some measure exposed to the moist

Nevertheless the tops of transverse chains and spurs crop out like islands above the recent alluvial formations and serve as an indication of the basal structure. The process of infilling is still in progress, but is advancing slowly. In the drier months winds are the chief agents in sweeping material from the mountains into the basin.

The Cordillera Real or eastern chain advances first north, then north-west through Bolivia and on into Peru. Recent volcanic phenomena, so striking a feature of this system in Argentina, are absent, but the Palæozoic slates and the granitic rocks which form the mountains have been freely intruded by igneous veins, in some places to such an extent that the latter form the bulk of the surface rock. East of La Paz in Bolivia the Cordillera

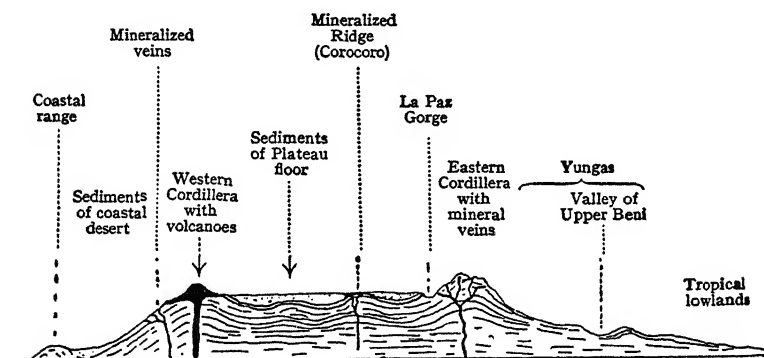


FIG. 38.—Diagrammatic Section of Bolivian Andes and Pacific Coastal Region along a line drawn N.E. from Arica

Real justly merits its name "royal." There it rises in a huge granite mass nearly 100 miles in length and averaging 20,000 feet in height. The outstanding summits such as Illimani and Sorata as well as the whole upper part of the range are covered with perpetual snows, rare except on isolated peaks in other parts of the Andes.

Eastwards from the Cordillera Real in Bolivia there is a relatively long slope to the Chaco plain and the llanos of the Marmaré Basin. The main features of the relief there are the series of lower ranges following in the main the same general alignment as the cordilleras enclosing the plateau, together with the numerous valleys of the rivers that rise on the high Andes and make their way to the Madeira and the Paraguay. The upper parts of these valleys between about 6,000 feet and 10,000 feet in elevation are called the Valles, while the lower parts between 6,000 feet and

1,500 feet constitute the region known as the Yungas. In relief, this region of the eastern slopes in Bolivia, with its less crowded contours, presents a striking contrast with the steep wall of the Andes throughout most of their length on the opposite side towards the Pacific.

About 100 miles north-west of Lake Titicaca, the inter-andine plateau becomes walled in by mountains at the Vilcanota knot. Northwards from this group a central range develops between the Eastern and the Western Cordilleras, and the last-mentioned range thenceforward constitutes the main watershed. The Apurimac and other headstreams of the Ucayali rising on the eastern flank of this western system flow north-west in longitudinal valleys and finally cut through the Eastern Cordillera, which gradually declines in height from the Vilcanota region and finally disappears into the lowlands about 10° S. As this chain weakens, the central range becomes more open to attack by the eastward flowing streams, and is, in fact, completely breached in latitude $12\frac{1}{2}^{\circ}$ S. by the Mantaro, whose two headstreams, one from the north and the other from the south, flow a considerable distance between the Western and the Central Cordillera before uniting to turn east across the latter.

The two ranges just mentioned converge towards 11° S. to form the Cerro de Pasco knot, whence a three-fold system of ranges develops once more northwards. There also two great rivers, the Marañon and the Huallaga, take their rise and flow roughly parallel with each other for several hundred miles between the ranges until the latter river breaks eastwards across the outer range. The Marañon itself crosses the Central Cordillera at about 5° S. and the somewhat low northern section of the eastern range by the Pongo de Manseriche gorge at $4\frac{1}{2}^{\circ}$ S. Slightly north of this, through the dropping out of the eastern range and the convergence of the two others, the Andes combine again into a compact mountain mass near Loja in Southern Ecuador, only to divide again into two well-marked chains as they do farther south in Bolivia.

The medial valley in Ecuador is comparatively narrow, averaging about 50 miles in width, and is sub-divided into a number of basins by cross-ranges that connect the cordilleran ranges. The Western Cordillera in this section is covered with thick deposits of volcanic debris ejected by the volcanoes which rise from it, and so also are large parts of the medial valley.

Just beyond the Colombian frontier, near Pasto, the Andes coalesce for the third time into a compact mountain system which serves as a starting point of the three cordilleras which traverse Colombia to about 8° N., where the western and the central

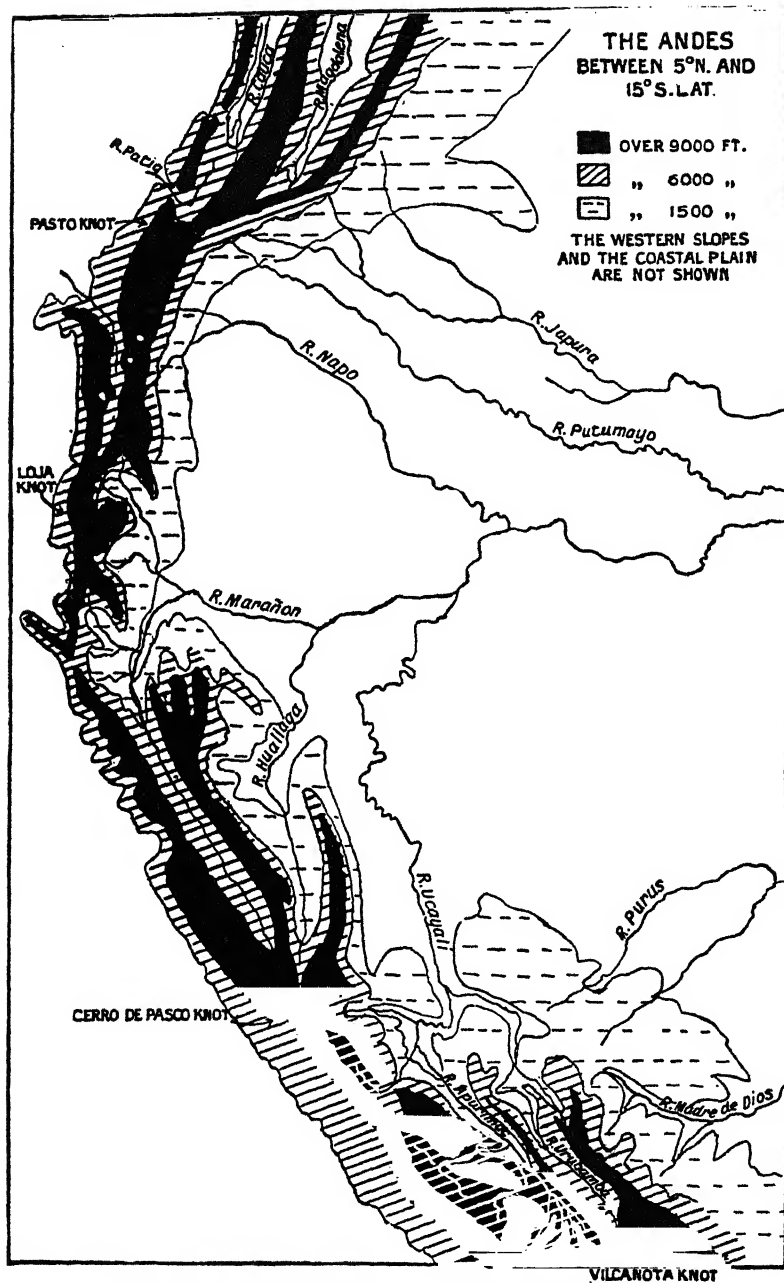


FIG. 39.—The Andes between 5° N. and 15° S. Latitude

chains die out. Near Bogotá the eastern chain widens out into a plateau of 8,000 to 9,000 feet in elevation and continues as such north-eastwards until it divides to form the Sierras of Perija and of Merida on either side of the Maracaibo depression. The former runs out to sea in the Goajira Peninsula and the latter breaks up in the Venezuela states of Lara and Falcon into a number of ranges, two of which run eastwards along the Caribbean shore, but in so doing, gradually weaken, allowing the Orinoco Plains to meet the sea at the Barcelona gap and the sea to cross them completely at the Gulf of Paria.

Owing to their enormous extension in latitude and to the great range in elevation between their lower slopes and their summits, together with the marked difference in the rainfall on either side throughout the greater part of their length, the Andes contain a bewildering variety of climates.

In the southern section from 40° S. to the Straits of Magellan, the upper levels consist either of snow-clad mountains or marshy plateaus; the western slopes suffer from excessive rainfall, while the ill-defined eastern slopes have a climate which is transitional between that of the upper ridges and that of the arid Patagonian Plateau. The only really habitable parts of the southern Andes are found in this zone of the eastern slopes where the rainfall is moderate to insufficient, and the severity of the climate, general at even moderate elevations in those latitudes, is modified by the sheltered position in the lee of the mountain system.

Between 40° S. and the latitude of Copiapó the rainfall that reaches the Andes is still mainly from the Pacific, so that the western side of the mountains is better provided with moisture than the eastern, which is more or less arid. The zone of heavy winter rainfall continues up the western Andes as far as 35° S. and then gradually falls off till behind Copiapó it is less than 10 inches even on the higher mountains. In the space of 12½° occupied by this part of the Andes, they increase considerably in height and steepness, and although advancing into warmer latitudes, are nowhere habitable except in the middle and lower parts of the valleys on either side.

The next subdivision of the Andes comprises the broad mountain area with intervening high plateaus, between 27½° S. and the Vilcanota knot. Here four distinct longitudinal climatic belts are recognizable: those of the pre-cordilleran ranges and middle slopes from Tucumán to the frontier between Bolivia and Peru, of the lofty cordilleras themselves, of the inter-Andean plateaus, and of the western slopes.

In the first of these belts the average temperatures are warm up to 6,000 feet elevation and hot in the valleys. The rainfall,

amounting to between 20 and 40 inches a year in exposed positions, is apt to be deficient for agriculture, but can be, and is, supplemented by irrigation. On the broad eastern slopes in Bolivia the climate is generally genial and in some favoured places has the qualities of constant spring.

On the high mountain chains from 13,000 feet to 18,000 feet and more above the sea the intensely low temperatures, the exposure to biting winds, and the general deficiency of moisture prevent any vegetation from establishing itself except the tufted ichu grass. Mineral wealth has attracted population to these altitudes, particularly on the Eastern Cordillera in Bolivia, but the people live under thoroughly unfavourable climatic conditions and are mainly dependent on the high plateau and other regions below for their supplies.

The plateau country between the lofty cordilleras, though arid and extremely inhospitable in the Argentine Puna, becomes more habitable in Bolivia, and by no means unfavourable to human settlement in the district north of Lake Titicaca. The climate is cold but sunny; the rainfall, however, is generally very low, averaging about 10 inches in the northern part of the plateau basin and less in the south, and confined throughout the region to the summer months. A certain amount of agriculture is possible in the less arid parts of the plateau, especially where irrigation can be applied, but the crops are limited to hardy plants such as barley and potatoes. The rearing of sheep, llamas and alpacas on the poor pastures on the other hand, is carried on over wide areas, mainly by Indians.

The Pacific slopes of the Andes, constituting the fourth climatic zone mentioned above, resemble the coastal strip below them in being extremely dry. They offer no relief from bare rock surfaces and steep slopes of fragmentary material except in the valleys of the rivers that derive water from the melting of snows on the Maritime Cordillera. Some of these rivers such as the Loa, the Azapa and the Tacna in Chile, and the Tambo and the Vitor in Peru, manage to reach the sea seasonally if not permanently, but the others disappear by evaporation and filtration before they get so far.

The western slopes of the Andes retain the same scenic and climatic features right on to the north-west of Peru. There, however, the Humboldt current begins to give way to an equatorial current, and rains are experienced more frequently than anywhere else in Western Peru. Inland from the summit of the Maritime Cordillera the climate of the Andean zone becomes progressively less arid until on the lower eastern slopes in the Montaña region it very closely resembles that of Amazonia. The

valleys and mountain slopes between the Western Cordillera and the Montaña support several millions of people who obtain their daily requirements from the districts in which they live. In the warmer eastern valleys maize and even sugar-cane are grown ; elsewhere the chief crops are wheat, potatoes and quinoa. A wide range of fruits is cultivated corresponding to the variations in elevation and situation, and in most of the valleys lucerne is an important fodder crop.

As on the coastal strip, so also, but not quite to the same extent, agriculture in the Peruvian Andes is dependent upon irrigation, the rainfall in the mountain zone, except on the almost inaccessible forested eastern slopes, being as a rule insufficient for agriculture. Thus, apart from mining centres, the population is settled largely on the valley floors and on the adjoining irrigable slopes. Many of these valleys lie at a great depth between the mountains bordering them, some of them resembling great ravines cut down from one to two miles into the heart of the mountain region. Throughout the Andes of Southern Peru and of the countries to the south, there exist widespread evidences of extensive glaciation during a recent geological period. When the southern Andes were covered with an ice sheet which advanced eastwards into Patagonia, it appears that glaciers were actively cutting down the valleys in Peru which are now left in many places with steep cañon-like walls.

Given these features in the relief of the Peruvian Andes, it follows that communication between one valley and the next and between most of them and the outside world is rendered very difficult. Such centres as Cuzco and Oroya at the points where valley heads lead to regionally different areas have naturally assumed special importance.

As already mentioned in Chapter II, the Andes from the Gulf of Guayaquil northwards lie within an extensive zone of summer rainfall ; they no longer separate two climatically distinct regions, and the mountains receive heavy rains on both their eastern and their western slopes. In fact, not only the mountains themselves, but also the Ecuadorian Plateau and even the deep Colombian valleys get a sufficient summer rainfall, and carry a relatively dense population supported in the main by agriculture. The low-lying parts of the river valleys in this northern section of the Andes have a hot and humid climate distinctly tropical in character. The plateaus of Ecuador and of Bogotá, together with the valley floors over 6,000 feet above the sea, enjoy an equable and very pleasant climate. Above 10,000 feet in elevation lie the bleak mountain regions known as paramos, occupied only by shepherds with their flocks during the summer months.

Wherever the rainfall is ample, as on the lower slopes of the mountains in Ecuador and Colombia, the natural vegetation consists of forests, tropical at lower elevations and sub-tropical to temperate higher up. The more or less populous plateau and valley regions mentioned above were originally covered in the main with grasses, and this circumstance not only favoured settlement at the outset, but has also no doubt contributed to the fertility of the soil and made possible the continuous cultivation of crops through several centuries.

The North-Eastern Andes pass into a region in which the seasonal distribution of the rainfall becomes more and more marked, and in which also there is a considerable variation in the amount according to situation with reference to the prevailing winds. Some parts, for example the low prolongation of the Sierra de Perija in the Goajira Peninsula and the valleys in North-Western Venezuela, are distinctly dry, and their vegetation resembles that of the north-eastern states of Brazil; other parts, such as the northern slopes of the Venezuelan Andes and the Island of Trinidad, receive more ample rains sufficient to support a forest cover in places. On the slopes towards the Llanos of the Orinoco the Venezuelan Andes are poorly watered and are covered more with brushwood than with forest.

As is well known, minerals have for centuries been a great source of wealth in the Andes. Even now the existence of many centres in the mountains depends solely upon the mining industry, which will be dealt with in the following chapter. Yet, taken as a whole, the great mountain system with its variety of soils and climates contains a far greater pastoral and agricultural than mining population. In pre-hispanic times the total number of inhabitants was probably at least as great as it is now, and mining was not then an industry of any importance. Thus there are not a few centres and routes whose development can be traced to the fundamental factors of topography, climate, and food supplies. Among these, such are the border towns of Salta and Jujuy in Argentina, La Paz, Sucre and Cochabamba in Bolivia, Cuzco and Arequipa in Peru, Quito, Bogotá and Caracas in the Northern Andes. Every one of these is situated in the midst of a relatively fertile tract, and five of them occupy commanding positions with reference to lines of communication and intercourse.

Salta and Jujuy are in especially productive valleys on the line of oases leading from the plains to the Bolivian Plateau. La Paz, itself in a river valley, controls the northward route by way of Lake Titicaca into Peru and also the route by the gorge through the mountains to the eastern valleys and slopes; it is close to the narrow neck between the open plateau to the south and the

corrugated plateau with deep and relatively rich valleys in Peru, and at the same time it serves as a centre for exchange between the cold temperate products of the elevated regions and the tropical products of the Yungas. Cuzco is even more favourably placed, since it occupies a basin in the valley of the Urubamba River at an elevation where the climate begins to be genial. Southwards from the town lies the great plateau basin; northwards the fertile river valley which becomes increasingly warmer downstream, and east and west of it are mountain pastures producing commodities that find ready exchange in a typically agricultural valley. Arequipa, situated on an oasis caused by the broadening out of a snow-fed river as it descends the Western Cordillera, is a natural halting-place on the desolate and difficult route between the sea coast and the plateau area adjoining Lake Titicaca, and is an important market centre for sierra Indians.

Very few of the railway or other routes in western South America cross the Andes completely and directly, so as to link the interior plains with the Pacific coastal strip, though six lines in all have been built across the Maritime Cordillera into the first longitudinal valley or the plateau beyond. Two of these are mineral lines almost pure and simple, namely the Central Peruvian (Oroya) and the Antofagasta and Bolivia, but the four others, the Buenaventura-Cali, the Guayaquil-Quito, the Southern Peruvian and the Arica-La Paz have been constructed as general-traffic railways to serve as links between the mountain region and the sea.

Several of the Pacific railways on reaching the inter-andine plateau proceed north or south for greater or shorter distances. The Guayaquil-Quito follows the medial valley for 150 miles and the Central Peruvian turns north to Cerro de Pasco. There is not the slightest prospect at present, however, of the 600 to 700 miles gap between these lines along the plateau region being bridged. There is somewhat more possibility of a link being constructed between the terminus of the southern branch of the Central Peruvian line and Cuzco. So far this branch has reached Huancaayo and is planned to follow the Mantaro valley by Huancavelica and thence to Ayacucho. Between this last point and Cuzco there are 150 miles of very mountainous country which is now bridged by a motor highway. Much the most striking plateau route in South America, or indeed in the world, is that which proceeds south from Cuzco to Lake Titicaca, traverses or skirts the lake, and then continues by way of La Paz, Oruro and Uyuni to the Argentine frontier, where it joins with the route to Buenos Aires. Over the whole distance between the old Inca capital and the Pampa the only gap which now remains

in the railway is that between the northern and southern shores of Lake Titicaca, over which there has for some time been a steamer service.

As on the Brazilian Plateau, so in the Andes, railways are so much more efficient as means of transport than mule-tracks that as soon as they are constructed into the mountains or along the plateaus and valleys they monopolize the traffic, and the older means of moving goods and people are relegated to a subsidiary position as feeders to the railways.¹ Among the widely-scattered productive districts of the central and northern Andes, many must for long years remain isolated. If agricultural, they will continue to exist as unprogressive self-contained communities; if mining centres, they have little chance of survival unless connected by railway or motor road with the outside world.

Though some 18 millions of people are estimated to live in the tropical Andes, the proportion of whites is generally very low, and the number of whites and mestizos taken together smaller than that of the Indians. The latter are stolid, indifferent to progress, and live at a low subsistence standard. The whites, and the mestizos who pass for whites, form a sort of propertied aristocracy and the Indians a depressed labouring class. The absence of a substantial peasant farmer class has been an obstacle to the growth of a prosperous form of agriculture among the scattered communities of the high Andes. The Spanish colonial system is to be blamed for much. It has reduced the Indians to the mentality of slaves and at the same time, by its method of parcelling out the land, made it impossible for Europeans to settle in any considerable numbers. In recent years, however, large mining and other companies of European or North American origin have arrived on the scene, and through the introduction of railways, machinery and vigorous methods of business, are engaged in transforming first one place and then another into something very different from that which it has been for four centuries.

¹ Since about 1935 all but the most backward South American republics, realizing the importance of internal development, have undertaken the construction of motor roads and have established national air transport services. These have been rapidly extended since 1940, especially since 1946, and many places, formerly served imperfectly by railways, or not at all, have been brought by these means into the orbits of the national economies.

CHAPTER XIX

THE ANDES—MINERALS

THE wealth and extent of the mineral deposits of any area are intimately related to its geological formation. In South America there is a marked contrast in structure between the widely intruded folded rocks that compose the Andes, and the recently formed horizontal deposits of alluvial material in the adjoining lowlands. The former contain extensive resources in a great number of valuable minerals but are poor in fuels; the latter are devoid of anything in the way of mineral deposits except petroleum and salts.

The lack of coal in many mining districts of the Andes, and of firewood also in the whole central section where minerals are abundant, has been a factor which has retarded the development of mining in proportion to the undoubted wealth of the deposits. Several large concentration and smelting works have recently been erected by American and other foreign syndicates in the mountain regions of Chile and Peru, but except for these and the recently constructed iron and steel plants at Volta Redonda in Brazil and at Huachipito (near Talcahuano) in Chile, no large metallurgical works have been established in the continent.

The shortage of fuel to work the mines and to treat the ores, together with the general inaccessibility of the richer deposits high up in the mountains, has caused the mining industry to be selective of workable deposits and hampered in its general forms. In the first place, the precious metals have claimed an undue share of attention till quite recently, when the extension of railways has put them into their proper place of minor importance. Secondly, the produce of the mines has found its way as soon as possible into the export trade, often as crude or partially refined ore, scarcely any being retained for local use. Thirdly, only the richer and more accessible deposits have hitherto been worked, since there has been no means of dealing locally with low-grade material. Fourthly, where as in the northern Andes the rainfall is sufficient to give rise to vigorous streams, attention has been, and still is, concentrated upon the alluvial gravels, and the rock ores have been largely neglected.

Vast quantities of gold and silver were exported from the Andean region during the three centuries of Spanish rule, and much greater quantities of other metals, such as copper, tin and mercury, have been removed from it and sent abroad since the independent republics were established ; but in neither case without much benefit to the local population. During the colonial period the enrichment of Spain by means of the precious metals wrested from the Andes took place at the expense of the native population, and since the termination of that period foreign syndicates have been the chief gainers. For owing to the aridity that characterizes much of the richer mineralized areas of the Andes, there is little place for the independent prospector ; minerals in the dry regions occur only in massive ores, and the working of these in barren and inaccessible places requires an elaborate large-scale organization to provide equipment, food supplies and the transportation of the crude ores for treatment elsewhere. Thus foreign capital enjoys at the present time a considerable measure of control over the more important branches of mining in the Andes, and so far as material advantage is concerned, the owners of this capital have become to some extent the heirs of the former Spanish rulers. In quite recent times, however, especially since the outbreak of the first Great War, South Americans have begun to interest themselves in the exploitation of mineral deposits on their own account, and it is probable that, as time passes, an increasing proportion of mining ventures in the Andes and elsewhere in the continent will come into their hands.

Geological Structure of the Andes

The main features of the relief of the Andes have been dealt with in the preceding chapter and it will be convenient here to describe their geological structure as a preliminary to the study of the mineral deposits.

The Andes as a whole differ from the eastern plateaus of South America, firstly, in having been elevated to their present height quite recently, and therefore in comprising extensive series of later sedimentary rocks ; secondly, in having been subjected throughout the whole length of the system to great volcanic activity, a phase that is still in progress, though now apparently drawing to a close ; and thirdly, in the absence of marked denudation on either side, except in the eastern Andes of Peru and Bolivia, throughout the 40 degrees of latitude from the Equator southwards.

In general, the Andes consist of great masses of folded sedimentary rocks through which at certain points the central granitic core has been raised, or in some places intruded, to form

the summits of the system, particularly where denudation has been sufficiently active to remove the overlying sediments, as in parts of the southern section, in the Eastern Cordillera in Bolivia, and in the central Colombian chain. From the point where the system diminishes in height and begins to weaken in the south to beyond where it breaks up into separate ranges in the north, huge quantities of volcanic debris have been thrown out on the Western Cordillera, as well as in Northern Argentina on the Eastern, and piled up so high as now to form many of the highest peaks.

Subterranean forces have been at work in the Andes in another direction also, and on a grander scale than anywhere else in the world. Igneous material from below has been forced to the surface in the form of veins and dykes throughout the length of whole chains, and in some places is so abundant as to have completely shattered the original surface strata.

These intrusive rocks, mainly diorites, andesites and porphyrites, have been responsible for most of the extensive mineralization that has occurred in the Andes. Wherever recent volcanic materials cover the surface, there is little chance of workable veins being discovered; but with the volcanoes are associated two minerals, namely sulphur and borax, found also in similar districts in other parts of the world. The only mineral of the Andes not due to igneous intrusion or recent volcanic activity is the Cretaceous and Tertiary coal occurring in various scattered pockets in Northern Peru and in Colombia.

The sedimentary rocks of the Andes consist mainly of Mesozoic and Tertiary strata together with Palæozoic series in places. The Southern Andes from 35° S., much of which has not been properly explored, apparently consist largely of the later sedimentary formations with considerable accumulations of volcanic materials both among and above these. Intrusive veins seem to be absent; at all events, no mineral deposits of any importance have been discovered as yet in this southern section. From 35° S. on to Southern Peru the main ranges of the Andes are composed of Palæozoic slates, greywackes, sandstones and quartzites, ranging in age from Cambrian to Devonian. These are overlaid, especially in North-Western Argentina, by Jurassic and Cretaceous strata, above which in many places there are extensive Tertiary outpours of lava. In the Eastern Cordillera of Bolivia, the later sedimentary series are missing from the summits of the mountains where early Palæozoic rocks and granites prevail, but on the slopes towards the Chaco there are extensive Cretaceous and Tertiary deposits. The forces which gave rise to the widespread volcanic outbursts in the Western

Andes of Bolivia and in the main mountain system to the south, have caused igneous material to be intruded through the Palæozoic and Archæan formations of the eastern chain in Bolivia, so that the veins are now exposed at and just below the summits of the mountains there. The scattered mineral deposits high up in the pre-cordilleran ranges in Argentina, and the line of mineralization in a similar position on the Western Andes in Central and Northern Chile, are also apparently due to the great igneous activity which accompanied the uplift of the mountain system in Tertiary time.

The Cretaceous limestones on the eastern flanks of the Andes have apparently been the source of the petroleum which, as already mentioned, has been found in small quantities at various places at the base of the mountains in Argentina, and which is thought to exist in much larger quantities in the transition zone between the Andes and the Chaco in Bolivia.

North of Bolivia the ranges which make up the Andean system show differences in geological formation similar to those in that country. The Eastern Cordillera in Southern Peru represents a continuation of the Palæozoic rocks, intruded in places by a granitic core, characteristic of the eastern range in Bolivia. The Central Peruvian Andes show a great development of Jurassic and Cretaceous strata, which also predominate in the Western Cordillera, but the Jurassic series disappears northwards and in Ecuador the Maritime Range is composed mainly of Cretaceous rocks. In Southern Peru all three ranges have been intruded by igneous veins, but not intensely, and similar veins are found at many points along the western flank of the Andes through Central and Northern Peru and Ecuador. From the Vilcanota group northwards minerals are found only in the Western Cordillera and on the western slope of the Central Cordillera in Peru, and are absent from the exclusively crystalline rocks of the Eastern Range in Ecuador.

Between 35° S. and the Colombian frontier there is thus a marked curve in the great line of mineral-bearing intrusions in the Andes. This line follows the western slopes as far north as Bolivia, then swings abruptly across to the Eastern Cordillera where it remains until, in Peru, it works back to the western chain at about 14° S. Hence the mines in Bolivia are much farther from the Pacific than are those of Chile and Peru, but, in spite of this disadvantage, were the most actively worked of all during the colonial period owing to their great wealth in silver ores.

In the Colombian Andes granite and other crystalline rocks form the cores of both the Central and the Western Cordillera, but the flanks of these ranges are covered extensively with Cretaceous and Tertiary deposits, while the earlier of these series

composes the great bulk of the Eastern Cordillera. Igneous intrusions occurred extensively in the Western and in the Central Range during the early Tertiary period and were followed by great volcanic activity in the same ranges in the late Tertiary, a phase which has persisted to the present time. The Cretaceous rocks in various parts of Colombia, like those in Peru, contain seams of coal, especially in the Eastern Cordillera northwards from Bogotá and in the Cauca valley, and calcite veins in limestone on the plateau region of Bogotá have for centuries been the world's most important source of emeralds.

The lofty continuation of the Eastern Cordillera of Colombia is known as the Sierra de Merida in Venezuela. Geologically it consists of a central core of gneiss and granite with Cretaceous and Tertiary deposits on the flanks of the mountains, and a similar structural arrangement appears in the Caribbean ranges to the east. Volcanic eruptions do not appear to have played much part in the upbuilding of the Venezuelan Andes, but there is a relative abundance of mineralized rock, very little of which, however, is worked at the present day. Deposits of inferior coal occur in the Cretaceous and Tertiary rocks of the Andean system in Venezuela at a number of places, but like those in Colombia and Peru are often in inaccessible situations, and only those are mined which are within easy reach of populous centres.

Mineral Deposits of the Andes

Of the minerals produced in the Andes the first that attracted attention was gold. It so happens that the northern part of the continent, that which earliest became known to the Spaniards, contains nearly all the important deposits of that metal in South America, most of these being in the Andes from Southern Peru northwards. Gold occurs in the mountain districts of Venezuela, Colombia, Ecuador and Peru. In the first of these countries the Andes, however, contribute less gold than the Guiana region, and gold-mining in them is comparatively unimportant now. In Colombia, the land of the fabled El Dorado, over 400,000 ounces per annum are still produced, an amount approaching that of all other South American countries combined. The output is derived mainly from alluvial diggings, but also from regular lode mining, in the central and western cordilleran zones. In Ecuador gold is the only mineral now worked. It is obtained both from alluvial gravels and from veins distributed along the mineralized zone in the Western Cordillera, chiefly in the three southern provinces and in the north-west. In Peru, which has been famous in the past as a source of gold, the metal is still widely mined and stands relatively high among the exports of the country by values. The southern provinces (Puno, Arequipa

and Apurimac) have been more important in this form of mining than the rest of Peru in recent years, though gold-bearing ores are being actively worked also at Cerro de Pasco and in the provinces of Libertad and Ancachs.

Just as gold is confined largely to the Northern Andes, silver is found mainly in the Central Andes. In Peru the gold-bearing and the silver-bearing zones overlap and cause that country to be pre-eminent now, as it has been for centuries, among all the countries of South America in the output of the two metals combined. Most of the silver now mined in the Andes is found associated with other metals in the ores: in Peru with copper and with lead, in Bolivia with tin. In the early colonial period silver was obtained by the Spaniards not only from the extraordinarily rich ores at Potosí, but also at a great number of other places, mainly in the western range of the Andes, between Northern Peru and Central Chile. The fall in the price of silver, particularly during the last fifty years, has more or less put an end to silver-mining *per se* in South America, but considerable quantities of the metal are still produced incidentally, as above mentioned, to the mining of other metals. The most important districts now are therefore those in which these other metals are obtained, namely the Peruvian departments from Libertad to Huancavelica, and the departments of La Paz, Oruro and Potosí in Bolivia.

The leading mineral produced in the Andes, in point both of value and of quantity, is copper. A zone rich in ores of that metal follows the Western Andes in Peru from Cerro de Pasco southwards, appears in the central part of the Bolivian Plateau at Corocoro where there are deposits of native copper, and then traverses the mineralized region of the Maritime Andes in Chile as far as O'Higgins Province. It appears that this belt contains far greater resources in copper ores than any other region in the world, and South America now contributes a greater proportion of the world's annual production of the metal than any other continent except North America, which has led in this direction for some three decades. Difficulties of transport and of fuel supplies have hitherto prevented exploitation except in selected localities, and there only spasmodically. However, a change has come over the methods of mining for the less valuable metals in the Andes during the present century, and the transformation is calculated to give greater permanence and stability to the industry in the more important mineralized areas. Large concentration works have been erected in the Western Andes at places where enormous deposits of ores are tapped by railways. In copper-mining such are those of the Cerro de Pasco Mining Company at Cerro de Pasco, connected by a branch line

with the Central Peruvian or Oroya Railway, those at Chuquimata on the Antofagasta and Bolivia Railway in Chile, those of the Anaconda Company at Potrerillos in Atacama Province, and those of the Braden Company at El Teniente on a branch of the longitudinal railway from Rancagua south of Santiago.

The tendency at present is for all forms of mining in the Andes, excepting only the alluvial diggings of the wetter northern zone, to be concentrated at centres that favour large-scale operations. Mines in places out of reach of railways, unless the ores are very rich, suffer from a fatal handicap. Thus rich and extensive deposits of copper and other minerals are left undeveloped pending opportunities of working them economically. This does not apply with such force to the ores in the more accessible coastal range and the western spurs of the Andes in Chile; there mining operations, particularly for copper, have been, and still are, conducted on a small scale at a great number of places.

Two copper-mining centres in the Andes, in addition to those mentioned above, are of considerable importance. One of these is that of Corocoro in the plateau of Bolivia on the Arica-La Paz Railway, where the metal occurs in a dioritic ridge that crosses the plateau longitudinally, and the other is at Collahuasi, some 15,000 feet up the Andes in the province of Tarapacá in Chile. The Corocoro deposits furnish nine-tenths of the Bolivian output of copper, just as those in the neighbourhood of Cerro de Pasco furnish approximately the same fraction of the Peruvian; but while there is every likelihood of further extensive bodies of copper ore becoming known in Peru, the same does not apply to Bolivia. The mineral wealth of that country lies almost entirely in the Eastern Cordillera, where igneous intrusions have brought other than copper ores to the surface in great abundance. There, as already seen, the basal formations belong to a much older geological period than those in the Maritime Cordillera of Peru and Chile. Limestone is absent, and the conditions have apparently not been favourable to the deposition of copper in the veins, or contiguous to them.

This mineralized zone in Bolivia is rich in tin and silver, and contains also deposits of gold, of bismuth, and of tungsten. Its earlier importance as a source of silver is now completely overshadowed by the rise of tin-mining which yields much the greatest of the country's exports by value. Bolivia, in fact, stands third among tin-producing countries, and accounts for 15 to 18 per cent. of the world's annual output.

Tin ores occur in the Eastern Cordillera in the three departments of La Paz, Oruro and Potosí, in all of which silver is often associated with the tin. During the colonial period the then less

valuable metal was either overlooked or neglected in the eager search for silver, and mining was accordingly most active where the latter was most abundant or accessible. For a time the

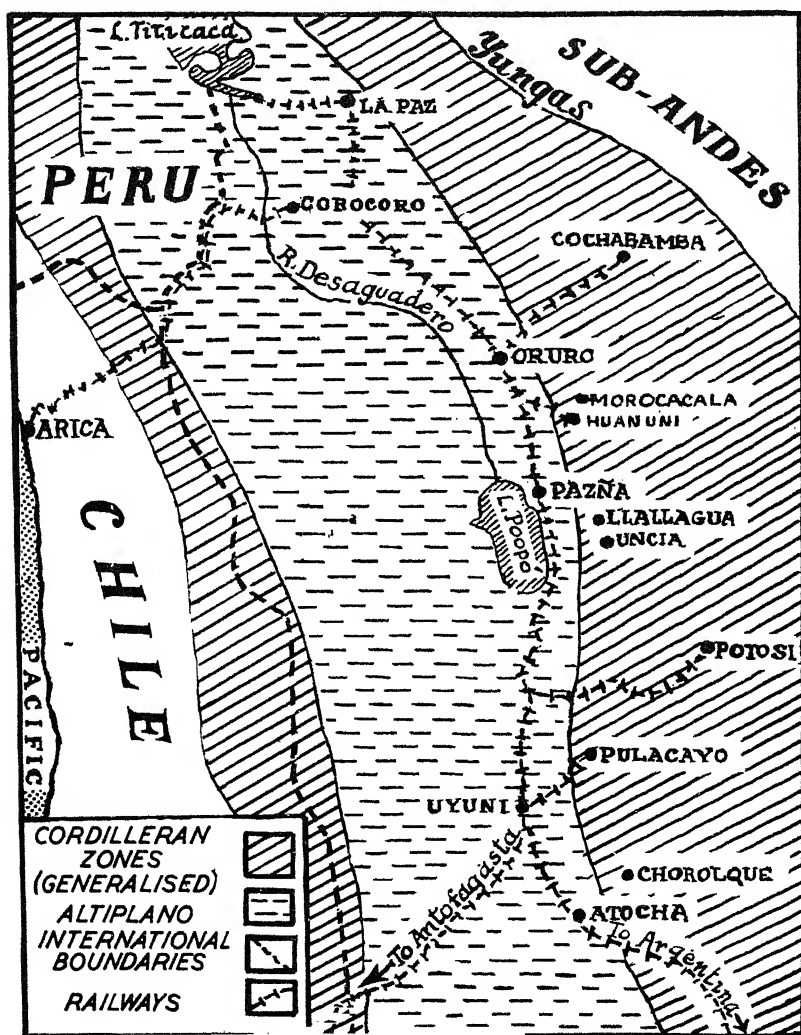


FIG. 40.—The Mining Centres of Bolivia

famous silver-mining centre of Potosí was the largest town in the Western Hemisphere. Such have been the changes since then in the relative values of tin and silver that part of the present output

of the former is obtained by working over the tailings from the old silver mines.

A little silver is still produced, some from the rich ores in the Pulacayo district near Uyuni, but mostly as a by-product from the tin mines. These are situated in the main at some eight centres dotted along and east of the railway from Oruro to Atocha. South-east of Oruro, the most northerly, are Huanuni and Morococala, lying close together about 35 miles distant. The next centre southwards is Pazña on the railway and opposite to the northern end of Lake Poopo, with Uncia and Llallagua about 30 miles to the south-east. The two remaining centres are Potosí, now connected by a branch line with the arterial railway, and Chorolque, about 30 miles north-east of Atocha. These eight centres furnish nearly three-quarters of the whole Bolivian output of tin. Of the above-named centres the most productive are those of Uncia and Llallagua.

The richest Bolivian ores contain from 6 to 8 per cent of tin, but in order to save transportation costs, the general practice is to concentrate the crude material as near as possible to the mines to a tin content of from 55 to 65 per cent. In spite of the great wealth in ores, Bolivian mining labours even more heavily than does that in most other Andean centres under a number of difficulties: the altitudes at which the veins occur are very high, mostly between 14,000 and 16,000 feet; transportation is very expensive owing to the rugged relief of the mining zone and its distance from the sea; fuel is exceedingly scarce, and there is little likelihood of hydro-electric power being developed to serve the mines on any but a very small scale, so that much of the concentration has to be done by hand picking; and yet labour is difficult to get, since the general unproductiveness of the plateau causes it to support only a scanty native population from which to draw workers accustomed to high altitudes.

The production of bismuth in Bolivia, obtained incidentally from workings for other minerals, is now small, amounting in recent years to about 2 per cent. of the world total, compared with 17 per cent. from Peru. The leading centre of production is Chorolque, where a mountain rising to some 20,000 feet in height yields tin ores near the summit, and silver, tungsten and bismuth ores at lower levels; and generally, in Bolivia, the bismuth ores which occur in the form of chlorides and sulphides, follow the line of stanniferous ores, but at lower levels.

The Andean region is now the source of an important part of the world's annual production of two somewhat rare and valuable minerals, namely platinum and vanadium. The former is found in the river gravels of Western Colombia in the valleys of the

Atrato and S. Juan Rivers, and particularly in the valley of the Condoto River, an Andean tributary of the S. Juan. In the last-mentioned district large-scale dredging operations have been in progress since the early years of the war of 1914-18, when the cutting off of Russian supplies caused a marked rise in the price of the metal. In spite, however, of the fact that Colombia is one of the leading countries in the world in the production of

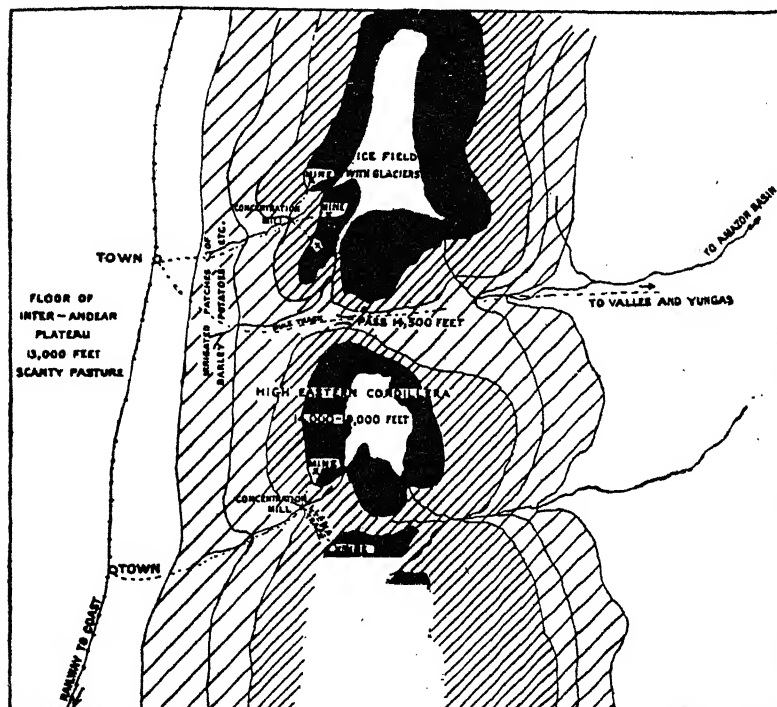


FIG. 41.—Regional Diagram to show Mining Region of the Eastern Cordillera of Bolivia

platinum, the metal stands low in value among the country's exports, much lower than gold.

Vanadium is apparently widespread in the western part of Junin in Peru, south of the Central Railway, but the most important deposit of this mineral in the world occurs north of the railway at Minas Ragras, over 16,000 feet above the sea, where 40 per cent. of the world's requirements is produced. There the vanadium ore (patronite) is associated with seams of carbonaceous materials, all of which are found in thick beds of limestone, and

it appears to be due to replacement along zones of crushing consequent upon the great crustal movements that have raised the mountains. Among the extensive mineral exports of Peru vanadium follows copper, lead and gold in value.

The highly mineralized region of Western Peru, up to which the Central Railway via Oroya has been built, contains not only the very extensive copper-silver ores at and in the neighbourhood of Cerro de Pasco, together with the deposits of vanadium just mentioned, but also quite important deposits of mercury ores at Huancavelica in the upper valley of the Mantaro River. These ores occur at a height of 14,000 feet in intrusions in sandstone strata interbedded with limestone, the whole series now standing almost vertical in the midst of the wildest type of arid mountain scenery. They have been worked from time to time ever since about the middle of the sixteenth century, the mercury being required in the colonial days for the recovery of silver elsewhere in Peru. That part of Junin which lies between 11° and 12° S., i.e. the mountain district bordering the upper Mantaro Valley, produces also lead, antimony, bismuth and molybdenum, and this district as well as the whole department contains various deposits of coal, one of which is now worked near Cerro de Pasco to supply the large smelting and concentration plant that has been erected there.

Mention has already been made of the association of silver with tin in Bolivia, and with copper in Peru. In the latter country, however, both gold and silver also occur in lead ores, and the mining of the precious metals in Peru consequently leads also to the production of appreciable quantities of the base metal, not from any region in particular, but from the various mineralized zones scattered along the Peruvian Andes.

Borax and sulphur, both of which owe their concentration mainly to volcanic activity, are very abundant in the Andes, where there are more active and recently dormant volcanoes than in any other mountain zone in the world. With regard to borax, it is said that Chile alone could furnish the whole world for several centuries. Owing to their situation, however, in the higher parts of the mountains, most of the Andean deposits of both sulphur and borax are too inaccessible to be worth exploitation; the sulphur is found on the slopes of lofty volcanoes, and the borax in the salars lying 12,000 feet and more above the sea in the central region of the Andes.

Of the deposits that are being worked for borax, the most important are those of the Salar de Ascotan in Tacna Province in Chile, of the Salinas Grandes salar on the western border of Salta and Jujuy in Argentina, and of the Laguna de Salinas,

which lies at an elevation of more than 14,000 feet not far from Arequipa in Peru. The first of these has the advantage of being close to the Antofagasta and Bolivia Railway, but it is really only one of a number of borax deposits along the volcanic chain of the Western Andes, and so abundant as to permit of the transportation of dissolved borates by underground drainage to the nitrate pampas below.

Sulphur, though common enough in the tropical Andes, is not worked on any appreciable scale except in Northern Chile, where the nitrate fields near by give rise to a local demand for sulphur for blasting powder. Deposits have been worked in the eastern parts of the five northern provinces of Chile, but two sources, the Tacora district in Tacna Province close to the Arica-La Paz Railway, and the Ollaguë district in Antofagasta on the route of the Antofagasta and Bolivia line, are now the leading ones.

The extraordinary mineral wealth of the Andes is worked chiefly in four widely separated and somewhat limited areas. From north to south these in order are the middle Cauca Valley and the adjoining Pacific slope in Colombia, the region tributary to the Central Railway in Peru, the Eastern Cordillera in Bolivia and the Western Cordillera behind the nitrate zone in Northern Chile. These contribute perhaps three-quarters of the total value of the Andean output of minerals. Gold, silver, platinum, vanadium, tin, copper, mercury, lead, tungsten, bismuth, molybdenum, sulphur and borax are each produced in one or more of these regions. Some of the minerals mentioned occur extensively in other parts of the mountain system, but only in a few places outside the four regions mentioned is the mining industry carried on to any appreciable extent.

In no comparable region in the world have such quantities and such a variety of igneous rocks been forced through the crustal formations at such numberless points both in the flanks of the ranges and at their summits; nowhere else have the minerals brought up to the surface been so well preserved from the action of denuding forces as in the Central Andes; but in no other highly mineralized region do most of the ores lie at such high altitudes or in such bare and wild mountain country as they do from Ecuador to Southern Chile. Even within the tropics many of the richer deposits are situated quite near the snowline, sometimes, as in Bolivia, on rugged spurs between the glaciers. To the Incas the gold, silver and copper meant little, and the productive capacity of the soil in crops and pastures very much. Europeans when they came reversed this order of precedence, but in staking

so much on the minerals, they were gambling against heavy odds in spite of the abundance of ores on every hand. With characteristic daring the Spaniards tackled the wild and lofty mountains, established lines of communication and transportation across hundreds and even thousands of miles in the continent, faced the shortage of fuel best as they could, and exploited the Indians ruthlessly for labour; but failed either to win for themselves permanent prosperity or to make the Andes more desirable for human settlement than the Incas had done.

In reality the Spaniards were unsuccessful in such attempts as they made to overcome the natural obstacles in the Andes,

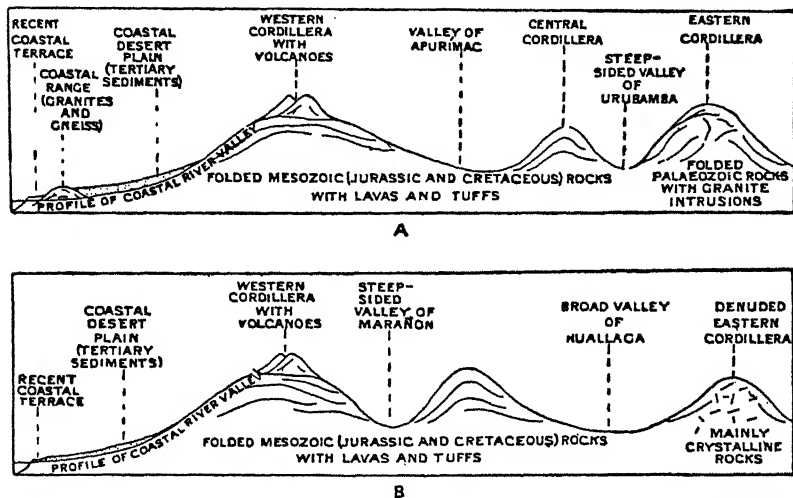


FIG. 42.—Diagrammatic sections across the Andes: (A) in Southern Peru; (B) in Northern Peru; both at right angles to the coast.

The profiles for the whole plateau region are those of tributary streams to the main rivers. The plateau is in reality much more continuous.

which, like the Amazon Valley in other ways, have remained a storehouse of natural wealth so easy at first sight, so difficult in fact, to open. The conquest of the earth by means of mechanical science never interested the Spanish people, and has appealed but little till recently to their descendants in the New World. It has been left for people of North European stock, furnished with a rich experience of mining problems in many parts of the world, to bring their ingenuity and specialized equipment to work on limited sections of the Andes, and there, and there only, has the conquest of the difficulties that have formerly beset mining in the Andes properly begun.

When all is said and done, however, it is probably true that

the permanent prosperity of the Andean region depends less on the exploitation of minerals than on agriculture and stock-rearing, neither of which was entirely neglected even during the colonial period, and both of which are capable of expansion, given better transportation, a more equitable distribution of land ownership, and a scientific study of the methods appropriate to the widely varying conditions in different parts of the mountains. The history of mining in the Andes throughout the colonial period and until quite recently shows that the industry has been of little benefit to the inhabitants. Mines there have in the past been a transitory source of wealth to all concerned ; they have hindered rather than helped the development on sound lines of the countries concerned.

CHAPTER XX

THE NORTHERN ANDES AND THE ADJACENT LOWLANDS

FROM the Central Railway northwards the Maritime Range of the Andes slopes steeply to the coastal plain except where, as in Northern Ecuador, it throws out a series of spurs which, gradually declining in height, break its fall towards the ocean. At intervals along the shore lie sections of a newer coastal range, especially north of the Gulf of Guayaquil, and these become continuous from the mouth of the S. Juan River to Panama. Only in this northern Colombian section and again in Ecuador does the Coastal Range present a barrier to the direct flow of rivers from the high mountains to the sea. Elsewhere the valleys cut across the outer system as though it never had existed. The zone between it and the Western Cordillera has been filled with Tertiary and recent sediments wherever the streams flow at right angles to the Andes. Such sediments form the floor of the coastal plain in Peru from Lima to Piura, though the coast range has disappeared over the greater part of the distance.

In the northern part of Piura Department, the horizontal Tertiary and Quaternary deposits are broken by an outlying range composed of old rocks and known as the Amotape hills. This range, running N.E. and S.W., has determined the direction of the coastline towards the Gulf of Guayaquil, and has also given rise to the westernmost projection of the South American continent in Punta Parinas. South of the Gulf of Guayaquil as far as Central Chile the erosive work of rivers in the coastal region has been confined to the excavation of single trench-like valleys, but north of the Gulf the heavy tropical rains have enabled the rivers to carve out wide main valleys with numerous tributary valleys, have produced a varied relief in the land surface and have contributed to a normally indented coastline which contrasts sharply with the unbroken lines along the arid zone to the south. Estuaries begin at that of the Daule-Guayas opening into the Gulf of Guayaquil, and this and a few others provide good harbours for shipping.

The coastal region adjoining the North-Western Andes owes some of its contrasts with that of Peru and Northern Chile to other factors besides heavy rainfall and vigorous erosion by streams. Whereas there are distinct indications of a recent rise in the shorelands all the way from Piura to Valparaiso, subsidence appears to have occurred along the coasts of Ecuador and Colombia, admitting the sea into the lower parts of the river valleys and causing the higher ground to project as headlands. Moreover, the considerable intact sections of the Coastal Range have provided a wall behind which the drainage collects into rivers larger than any others on the west coast of South America, and powerful enough to have developed considerable erosive power in their longitudinal courses terminating in the Pacific. The valleys of the Daule, the S. Juan and the Atrato occupy, in fact, considerable parts of the space between the Western Andes and the ocean, where the rivers flow parallel with the mountain system.

The Eastern Andes descend abruptly in Peru to the plains beyond, which join the mountains at a height of less than 500 feet above the sea. In this section the rivers break through eastern ranges by great gorges and afterwards meander quietly across the lowlands. North of the Marañon, however, the fall from high mountain to nearly level lowland takes place in two stages. First, there is an exceedingly steep descent to about 3,000 feet above the sea and afterwards a gentle one down to the fall line which occurs at a height of between 500 and 1,000 feet. It is thus possible to reach the montaña region of Peru from the east by means of continuous navigation on the rivers, but the sub-andine zone of Eastern Ecuador and Colombia is difficult of access owing to the occurrence of rapids on the rivers for several hundred miles of their courses after they leave the mountains. In this northern section the eastern slopes of the Andes and the adjacent zone intermediate between them and the low-lying plain, are covered with forests that increase rather than diminish in density up the mountain sides to about 6,000 feet above the sea. Cut off from the plateau and from the Amazon by natural obstacles, this piedmont zone, except in Peru, is likely to remain for long in its present state of isolation.

From the mountain mass between Pasto and Popayan in Southern Colombia, five rivers take their rise and flow in different directions: the Putumayo and the Japura south-east to the Amazon, the Patia west to the Pacific, and the Magdalena and the Cauca north to the Caribbean. Here the Andes narrow down to a single mountain axis resembling that of the St. Gothard range in the Alps, but glaciation has done little to carve passes

through the Pasto group of the Colombian Andes, and it remains a highly elevated region from which the duplicate mountain system develops and passes southward through Ecuador, and the triplicate system develops northwards and gradually sinks in its course through Colombia. The Western Cordillera contains several passes at a moderate elevation in Colombia, but not so

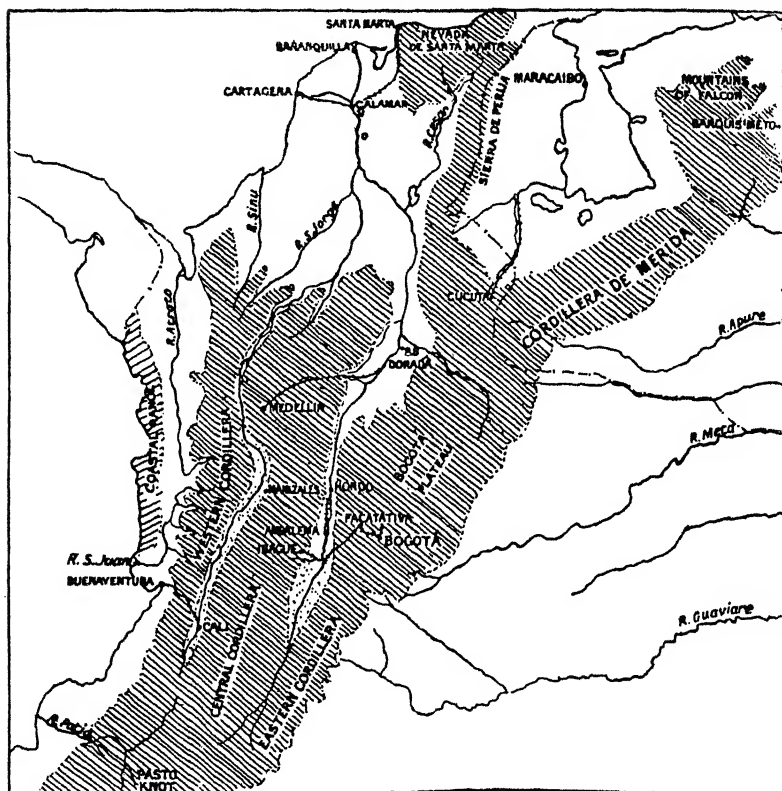


FIG. 43.—The Mountain and Adjoining Regions of Colombia and Western Venezuela

The dotted areas represent high valleys.

in Ecuador, where the railway from Guayaquil has to ascend to 10,600 feet before gaining the plateau. In Colombia, on the other hand, the Cauca Valley is accessible from the Pacific by several routes whose maximum elevation is between 3,000 and 6,000 feet, the Cresto de Gallo Pass, used by the railway between Buenaventura and Cali, being slightly over 5,000 feet.

The populated parts of the Cauca Valley are oriented rather

to the Pacific than the lower Magdalena and the Atlantic. The floor of the valley at Cali stands at an elevation of over 3,000 feet, and for a distance of 250 miles in its course below that town to the head of navigation at Carceres, the Cauca flows through a deep encanyoned valley and over numerous rapids. The central crystalline cordillera offers none but difficult routes into the upper valley of the Magdalena, which is itself somewhat isolated owing to the rapids at Hondo. Thus neither of the main river valleys affords a practicable outlet for the rich mining and agricultural region of the upper Cauca.

The Magdalena, on the other hand, occupies throughout its middle course a broad trough fault between the Central and the Eastern Cordilleras. Its valley is some 50 miles wide and the lowland plain penetrates a great distance up the trough in which the river flows. Unfortunately the alluvial tracts on the banks of the river are largely uninhabitable owing to extensive swamps and jungle vegetation, to the plagues of mosquitoes and to the prevalence of fever. It appears that the floor of the valley has subsided farther in recent times, and this accounts for the widespread swampy tracts and for the fact that the course of the river tends to get choked with sand brought down by tributary streams.

The plain upon which both the Magdalena and the Cauca emerge, after passing the northern end of the Central Cordillera, shares to some extent in the characteristics of the middle Magdalena Valley. It is ill-drained, and is covered in the wetter parts with dense tropical forest. Along the banks of both rivers in the lowland area there are numerous lakes, shallow for the most part, and representing overflow basins into which the rivers discharge part of their flood waters. Some of these, such as Lake Zapatosá, through which the Cesar River passes before entering the Magdalena, are of a considerable size.

The north-eastern section of the alluvial plain of Colombia is flanked towards Venezuela by the Sierra de Perijá, and towards the Caribbean by the high east and west range known as the Nevada de Santa Marta, which descends steeply to the sea, but is succeeded southwards by a series of parallel ranges of gradually diminishing height. The angle formed by the Sierra de Perijá and the Nevada de Santa Marta is drained by the Cesar River, which flows almost due south and away from the sea to join the Magdalena. The higher ground and the mountain valleys in the basin of this river are much healthier and more suitable to agricultural pursuits than the swampy lowlands along the Magdalena. The Santa Marta Plateau region, in fact, is one of the four districts which together contain the greater part of

the white population of Colombia, the other three being the Cauca Valley, the Bogotá and other plateau districts on the Eastern Cordillera, and the northern part of the Central Cordillera.

Though the greater part of the mountain region of Colombia drains by the Magdalena-Cauca-Cesar River system, the arrangement of the mountains diverging northwards like the ribs of a half-open fan is favourable to the development of independent streams following the north and south valleys between the various chains. Somewhat west of, and parallel with the lower course of the Magdalena, is the Sinu River, which drains the eastern slope of the Pacific Cordillera in the section north of the S. Jorge tributary of the Cauca; and the Atrato follows the relatively broad valley between the Pacific Cordillera and the Coastal Range. The latter river, like the Magdalena, is obstructed by sand-bars at its mouth, but is navigable for 280 miles above its delta as far as Quibdó. The Gulf of Urabá, into which the Atrato drains, is to be regarded as a northward and still submerged part of the longitudinal valley in which the river flows.

The limb which the Eastern Cordillera of Colombia throws into Venezuela continues as a vigorous system of parallel ranges as long as it follows its initial north-easterly direction, the principal range, that overlooking the Llanos of the Orinoco, being known as the Cordillera de Mérida. In spite of the general average height of this chain, several rivers have cut back into it, so as to drain towards the Orinoco parts of the mountain region behind the summit line. Owing to the lighter rainfall on the western side of the Venezuelan Andes the rivers that empty themselves into Lake Maracaibo are generally small, they diminish very much in volume during the dry season, and only one, the Chamuto, takes its rise beyond the front range on the west.

In the southern part of Lara State the high chains give place to a succession of more or less parallel ranges, nowhere exceeding 5,000 feet in height, which fall gently north-eastwards. These ranges, collectively known as the Coro group, occupy almost the whole of the broad peninsula between Lake Maracaibo and the Caribbean. Their western valleys are mostly too dry for settlement, but those towards the east are utilized for the rearing of live stock, especially of goats. The town of Barquisimeto occupies a gap which communicates south-east by the Cojedes River with the Orinoco plains and north-east by the Yaracuy Valley with the Caribbean. The irregular line formed by these two rivers separates the Coro ranges, together with the Sierra de Mérida lying to the west, from the Caribbean ranges to the east. The latter consist of two parallel chains between which there is a corridor-like hollow, high in places, in others

sinking towards sea-level and actually invaded by the sea at the wide opening on which the towns of Barcelona and Guanta stand, and again at the Gulf of Paria. Where this inter-mountain depression is well drained, as in the section west of Cape Codera, it carries a relatively dense population, but in the State of Sucre considerable parts are useless, being occupied by lagoons, lakes and swamps. Beyond the Gulf of Paria the depression is continued in Trinidad, where it is highly fertile and is moreover assured of an ample rainfall.

The great variety of climates found in the Andes as a whole (see Chapter XVIII) tends to be reproduced in some measure in any important tropical section of them. Though the Andean region from Central Peru northwards lies within about 11 degrees of the Equator, that is, in the inner tropical zone, the extraordinarily varied topography of the region resulting in differences in elevation and in exposure to the moisture-bearing air currents, causes both the climate and the natural vegetation to show sudden changes and wide contrasts. In North-Western Peru, for example, while the coastal lowlands are desert except along the streams from the mountains, a thin cover of trees and shrubs begins at 3,000 feet up the Andes and merges at about 8,000 feet into a belt of stunted evergreen forest. This vertical succession of practically desert coastal lowland, scrub-covered land on the intermediate slopes and forest country higher up the mountains, is common throughout the tropical parts of the world in districts that are unfavourably situated for rainfall. Similar series occur also in other parts of the Northern Andes, as for example, in the Goajira Peninsula, in the State of Falcon in Venezuela, and in the interior of Colombia, where some of the deep valleys are arid while the mountains have a cover of forest.

In the districts subject to abundant and well-distributed rains, on the other hand, there is usually a dense growth of tropical forest on the lowlands, on the lower mountain slopes, and in the deeper valleys among the mountains, above which at an elevation of 5,000 to 6,000 feet in Ecuador and in Colombia, there follows as a rule, but not always, a mountain type of forest more or less temperate in character. The latter kind is generally much more broken than the tropical forests lower down, partly because of the steep and rocky nature of the ground, partly because these elevated parts are often above the zone of frequent convectional rains, and partly also because the soil retains but little moisture in the intervals between one rainy period and another. Thus the plateau-like tracts at elevations of 8,000 to 10,000 feet are often covered with grasses rather than with trees or even with bushes.

These characteristics in the distribution of the vegetation are especially noticeable in the north-western part of Ecuador and on the Eastern Cordillera in Colombia. The tropical forests are

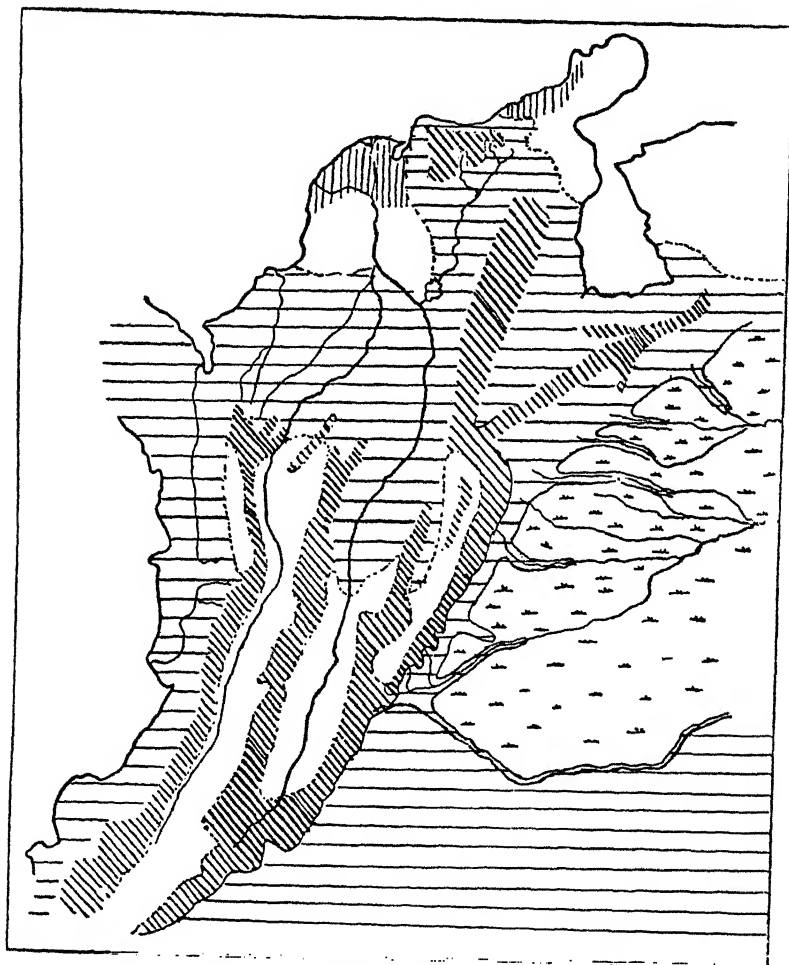


FIG. 44.—Vegetation Map of Colombia

The horizontal ruling represents tropical forest, the diagonal ruling mountain forest, and the vertical ruling the forest and scrub of the dry areas. The llanos are covered with mixed scrub and savannah. The unshaded areas are mainly grasslands.

practically continuous up to intermediate elevations from the Pacific shore in the former region and from the Meta plains in the latter, but in both give way, before the plateaus are reached, to sub-tropical and temperate forests, with intervals of forested

country which become continuous on the plateaus themselves. From the vegetation map of Colombia (Fig. 44) it will be seen that the entire Pacific slope in that country, except the uppermost part of the Western Cordillera, is covered with tropical forests, and that mountain forests occupy most of the high-lying zone between these tropical forests and the Cauca Valley. The unforested tracts which are found in Ecuador on the western mountain slopes and on the inter-Andean Plateau, are represented in Colombia, first, by a belt which lies mainly east of the Cauca in the valley of that river and on the Central Cordillera; second, by a similar but smaller area in the upper Magdalena Valley; and third, by the plateau belt of the Eastern Cordillera already mentioned.

Along the northern coast of Colombia, from the mouth of the Sinu River eastwards to beyond that of the Magdalena, there is a region, extending inland as far as the confluence of the Cauca with the main river, in which the climate is seasonally dry, and the vegetation cover, except in the swampy tracts along the rivers, consists of grasses or the open deciduous type of forest rich in leguminous species. Similar scanty growths occur also in the Goajira Peninsula and in certain places along the mountains bordering the Venezuelan coast.

The region round Lake Maracaibo in Venezuela is covered in places with tropical and sub-tropical forest. Towards the shores of the inlet there is generally a sandy strip in which very little grows, but farther inland there are wooded areas in which Spanish cedar is found. Beyond these the upland districts carry a savannah vegetation which gives place to the continuous forests on the slopes of the mountains. The mountain districts of Northern Venezuela are inclined to be too dry for trees, except in the more favoured situations which support the deciduous species mentioned above. Elsewhere the prevailing vegetation is brushwood and coarse grasses. In the extreme eastern section of Northern Venezuela and in Trinidad, however, the heavier and more regular rainfall permits of the growth of true tropical forest, especially at lower elevations.

Almost everywhere in the Andean region north of Central Peru the densely-forested areas have been left mainly in the state of nature. The forests themselves, consisting of mixed stands in which hardwoods predominate, have hitherto possessed little economic value, and there has accordingly never been any extensive timber-cutting industry in them except for mahogany in the northern part of Colombia and the north-western part of Venezuela. As a matter of fact, wherever the climatic conditions are favourable to the existence of continuous forests, they

are correspondingly unfavourable in these low latitudes to human settlement. The tropical forest regions on the slopes of the Northern Andes and on the adjoining lowlands have accordingly been entered upon only for the purposes of a few scattered extractive industries—by seekers for gold in the streams, and by collectors of special products such as rubber, cinchona and tagua nuts.

The rubber industry was formerly of some importance in the eastern sub-andine region in both Northern Peru and in Colombia, but has always suffered from the inaccessibility of the districts and the constant tropical rains. The cinchona industry was very prosperous from 1850 to about 1880, but the establishment of plantations in Ceylon and Java, which yielded a bark containing a higher percentage of alkaloid, caused such a fall in the value of the South American product after 1880 that it became no longer remunerative to search the Eastern Andes for the trees. The tagua nut industry has fared better. The palm from which the nuts are obtained grows over wide areas in the tropical forests of Colombia, Ecuador and Peru, particularly in the Pacific coast region of the two former countries. Tagua nuts, which furnish the vegetable ivory of commerce, are exported in considerable quantities from both Colombia and Ecuador, mainly to the United States.

The evergreen tropical forests of Northern Colombia and North-Western Venezuela have long been exploited to a limited extent for two relatively valuable timbers, namely mahogany and Spanish cedar, and the dry deciduous forests in the same region, for Brazil wood and *lignum vitæ*. Centuries of cutting have apparently depleted the easily accessible supplies, and the exports of all these timbers combined do not at present amount to very much. Here, as elsewhere in the forested regions of tropical South America, the development of the timber industry seems to depend upon the establishment of such methods of cutting as will make it possible to utilize a number of different species of trees instead of selecting one or two of the most valuable as hitherto. Proximity to the Panama Canal and the growing demand for hardwoods in the Northern Hemisphere will in time, no doubt, lead to the exploitation on more systematic lines than ever before of the undoubted wealth in timbers which exists in the Pacific regions of both Colombia and Ecuador.

The coastal forests of the Caribbean region, both the mangrove type along the shore and the deciduous type in the dry areas, yield tanning materials, the former mangrove bark and the latter *divi-divi* pods. Of much greater value than either of these products is an article known as *chicle*, which is obtained

from various species of the zapote tree found in the lower Magdalena and the Atrato Valleys, and is exported exclusively to the United States for the manufacture of chewing gum.

In spite of the glamour that has surrounded the mining industry in the north-western region of South America, agriculture together with stock-rearing is of vastly greater importance at the present day. The cultivation of the various tropical crops described in Chapter V is not generally, except in Peru, confined to the coastal lowlands, but extends up the mountain slopes and into the valleys of the interior, which up to elevations of about 4,000 feet are distinctly tropical in character in the north-western sector of South America. It is only remoteness and difficulties of communication that prevent the lower slopes and valleys of the Northern Andes from becoming of greatly increased economic importance, compared with the coastal lowlands, than they at present are.

Cacao, a tropical crop, and coffee, a sub-tropical one, supply the bulk of the exports of agricultural produce from the north-western region as a whole. The former is cultivated not only on the lowlands as in Trinidad, but also up to moderate elevations in Ecuador and Venezuela, but the districts suited to cacao are less congenial to Europeans than those suited to coffee, which flourishes in Colombia and Venezuela at elevations of 2,000 to 6,000 feet. Both countries produce the superior mild variety in steady demand at a higher level of prices than for Brazilian, and in both coffee constitutes the major item of agricultural exports. Colombia which produces about 400,000 tons per annum, over a third of the reduced Brazilian crop, and eight times the Venezuelan, is the second largest coffee exporting country in the world. In that country the plantations are distributed on both flanks of the Central Cordillera and on the western side of the Eastern Cordillera; in Venezuela on the slopes of the Cordillera de Mérida. Owing to the mountainous terrain, coffee is grown in these lands, not on large estates, but on many small farms, whence the produce is transported (often by pack-mules) to local centres such as Medellín, Bucaramanga, and Mérida.

For the cultivation of cacao, coffee and sugar, considerable quantities of moisture are essential, but cotton, as noted already (see Chapter XI), is much less exacting in this direction. Not only the irrigated valleys of Western Peru, but also the dry Caribbean districts of Colombia and Venezuela are climatically well suited to cotton, yet so far little progress has been made with the cultivation of this crop except in Peru. In Colombia, it appears, there are large areas in various parts of the country—along the northern coast from the Sinu and S. Jorge Rivers

and in the Goajira Peninsula, in the drier parts of the upper Magdalena and Cauca Valleys, and in the valleys and on the slopes of the Eastern Cordillera—that lack nothing but labour and capital to make them large producers of cotton. Yet, except for the somewhat perfunctory cultivation of a perennial species in the coastal region behind Baranquilla, the crop is neglected. In Venezuela cotton is grown on a small scale in the states of Aragua and Carabobo, whence considerable quantities of raw cotton were exported during the American Civil War. At the present time, however, the whole of the output is consumed in the local mills at Caracas, Valencia, Maracay and other centres. In Ecuador some cotton is produced in the lowland district in the neighbourhood of Guayaquil, but, there again, simply to meet local requirements. The fact of the matter appears to be that in all these scattered cotton-growing districts of North-Western South America, the climate is somewhat exacting for Europeans, the agricultural population is sparse, and the capital required to establish cotton cultivation on up-to-date lines is lacking.

The dense populations of some of the intermont basins and mountain valleys and the scattered population of the mountain region elsewhere in the Northern Andes depend exclusively upon local resources for their supplies of food, and such crops as wheat, barley, maize, and potatoes are extensively grown for consumption on the spot. Thus the most important agricultural areas of the whole region are to be found in some half-dozen populous districts; the plateau basins of Ecuador, the upper Cauca valley, together with the other districts in Colombia mentioned above (pp. 259–60), and the Caracas–Valencia basins of Venezuela.

Stock-rearing shares the place of importance occupied by agriculture throughout the inhabited mountain areas. Sheep are comparatively scarce, except at high altitudes, but goats are common both in Colombia and Venezuela, and particularly in the latter country, where they are the chief source of supplies of both meat and milk for the plateau and mountain population, since the climate is apt to be too dry for cattle. The open country in Northern Colombia from the valley of the Sinu River to that of the Cesar, on the other hand, contains considerable areas of well-watered grasslands which support something like 2 million cattle. Hitherto only live animals and hides have been exported, but it is probable that in the future some of the surplus animals will be converted into refrigerated meat.

The mining industry throughout the Andes proper has been described above. There remain for discussion the deposits of petroleum which occur at various places in the coastal arc from

the Tumbes district of Northern Peru to Trinidad, and are known to exist along the inner arc just east of the Andes.¹ The oil-bearing region of Northern Peru extends across the Gulf of Guayaquil into the Santa Elena district of Ecuador, but the most productive fields are the Negritos, Lagunitas and Lobitos in Peru. In this part of South America the petroleum is found in recently elevated Tertiary rocks which, during the final uplift of the Andes, were subjected to an extraordinary amount of faulting. Thus the oil occurs irregularly, but has been preserved in pockets through the sealing of the containing sands all round by shales belonging to a different horizon.

The production of oil from the Peruvian fields increased rapidly for a time, rising from under half a million tons in 1921 to about 1.7 million tons in 1926 and to over 2 million tons in 1938, but with little increase since 1948; in 1956 the Ecuadorian field produced some 480,000 tons. Both appear to be approaching exhaustion. The exploitation of the deposits is facilitated by their proximity to the sea, since they are all confined to a narrow band less than 20 miles in width which has been raised from the continental shelf by block-faulting along the line of the shore. A large refinery has been erected at Talara, where vessels are loaded by means of pipes carried into the sea.

In Colombia petroleum has been discovered in the lowland region near the mouths of the Sinu and the Magdalena; but the most important field in that country so far developed is that of Infantas, east of Barranca Bermeja on the middle Magdalena, some 400 miles up the river, from which a pipeline has been laid to a point on the coast south of Cartagena. The Colombian production was insignificant till 1926, when it leapt to a million tons, increasing to 3.2 million tons in 1946, and to over 6 million in 1956.

The petroleum deposits of Venezuela, especially those round Lake Maracaibo, are apparently extensive, and various large American and international companies have large interests there. In 1924 the Venezuelan fields produced 1.7 million tons of petroleum, a quantity greater than that from any other South American country in the same year. By 1956 the Venezuelan output rose to nearly 120 million tons.² The principal producing area so far is that of the Mene Basin, on the north-east side of the Lake and connected by means of a pipeline with the loading port of S. Lorenzo, where a refinery has been erected. Most of the

¹ A new field has recently been opened 25 miles south of Pucallpa where the Trans-Andean Highway meets the Ucayali River, but the outlets for the products seem small, the cost of transport by pipeline across the Andes being prohibitive.

² Approximately 15 per cent. of the world's production. Venezuela now holds second place among petroleum-producing countries.

crude petroleum is now, however, transported direct to a huge new refinery at Cardon on the Paranagua Peninsula. Since 1938 the north-eastern fields round the Gulf of Paria have been rapidly developed, the chief centres being Quirequire close to the gulf, Pedernales, and Oficina some distance north of Ciudad Bolívar. These fields extend eastwards under the Gulf of Paria, where wells are being drilled similar to those in the shallow waters of Lake Maracaibo. The petroleum is loaded at Guanta and Puerto La Cruz and refineries have been built at Carapito. Both asphalt and petroleum are produced on a considerable scale in Trinidad, which by 1938 produced over 100,000 tons of asphalt and $2\frac{1}{2}$ million tons of petroleum, with further increases to 136,000 tons and 4.15 million tons respectively in 1956.

We have already seen that the most populous districts in the Northern Andes are situated several thousand feet above sea-level and are therefore, as a rule, some distance inland. Most of them have been settled since the early colonial period, and their populations had consequently adapted themselves before the railway era to the self-sufficing type of economy imposed upon them by isolation. It is only with the building of railways and more especially of national highways that some of these settlements have come at all actively into touch with the outside world. With the mining centres it has been different: they have always had to find outlets for their minerals, and if situated in inhospitable places, they have also had to rely upon transported supplies of even the necessities of life. In quite recent times all inland centres of population, however remote previously, have begun to feel the influence of modern commercial organization. Markets are found for their produce, such as coffee, wool and skins, and manufactured goods are brought to them in exchange.

The population of the north-western arc of the continent tends, therefore, to be arranged in two main groups. Up in the mountains there are mining, agricultural and stock-rearing communities; along the coasts there are trading communities at the scattered ports which serve as outlets mainly for the highland areas, but often and sometimes exclusively, for their coastal hinterlands. In Northern Peru three major ports, Callao, Chimbote and Pacasmayo, discharge both functions, since railways from them penetrate the Andean region. Trujillo with Salaverry, on the other hand, though relatively populous and important, serves the coastal region only; but the irrigated valley there is one of the most productive in Peru. Guayaquil resembles the Peruvian port of Callao in that it serves as an outlet both for the lowland area behind it and for the populous plateau region to the east, which is reached by the railway from Duran

on the opposite side of the river. The succession of towns—Riobamba, Ambato and Quito—along the plateau basins points to the concentration of population in that region of Ecuador.

In Western Colombia practically the only port is Buenaventura, which occupies an unhealthy site surrounded by swamps, and which would never have come into existence were it not for the fertile Cauca Valley east of the Pacific Cordillera. The importance of the Magdalena as an internal highway is illustrated by the fact that two ports, Cartagena and Baranquilla, have developed, the former on the coast and connected by railway with the river navigation, the latter on the river, now accessible from the sea by a channel through the delta (cf. p. 61). Once these ocean terminals are passed, there are no important centres of population up the valleys of either the Magdalena or the Cauca below the 3,000-foot contour. Bogotá, Medellín, Cali, Palmira and Manizales are all situated between 3,000 and 8,500 feet above the sea. In North-Eastern Colombia the mountain country reaches the sea, as we have seen, in the Nevada de Santa Marta, and there the port of Santa Marta has sprung up as an outlet for the sub-tropical area on the mountains inland, and for the tropical banana-producing belt near the coast.

Lake Maracaibo is unfortunately somewhat shallow at its entrance, but it allows of the passage of small vessels. The principal port on the shores of the lake is Maracaibo, serving as a collecting centre for the whole inland waterway. From Encontrados, the head of navigation on the Catatumbo River, which empties into the south-western angle of the Maracaibo inlet, a railway has been built across the frontier into Colombia, thus providing an outlet for the Cúcuta region which, lying east of the Eastern Cordillera, is cut off from the Magdalena highway.

The arrangement of the railway system in Central Venezuela is an indication, in its simplicity, of the geographical distribution of the population in that zone. From the port of La Guaira a line, which is now electrified, climbs some 3,000 feet to Caracas, whence other lines branch east and west along the populous elevated valley between the two Caribbean ranges. Valencia on the western system, the Great Venezuelan, is connected by means of a short line with Puerto Cabello on the coast; from Valencia also, a connection with the railway south-west from Tucacas is in course of construction. When this link is completed there will be a main longitudinal line along the plateau with three coastal connections. The mountains in this zone adjoin the sea, the coastal plain is thus eliminated, and the ports are merely bottle-neck outlets through which the commerce of the plateau region passes.

CHAPTER XXI

THE CENTRAL AND SOUTHERN ANDES AND THE PERUVIAN AND CHILEAN COASTAL STRIP

THE broad belt of the Andes between 12° S., the latitude of Lima, and 21° S., that of Chorolque in Bolivia, though seldom less than 12,000 feet in elevation, except on its eastern flanks, carries now, as it has done for many centuries, a population of several millions of people. These are concentrated largely in the eastern half of the mountain system, because the water supply, both in the valleys and on the plateau, is generally more abundant towards the continental interior than towards the Pacific, and because also the chief zone of mineralization follows the Eastern Cordillera from Cuzco southwards to about the 21st parallel.

The coastal strip from Lima to Arica is crossed by a number of streams that rise in the Pacific Cordillera and form in their lower courses ribbon-like oases that enable upwards of half a million people to live in a region which is otherwise an unredeemed desert. Not all these streams, however, are suitable for irrigation purposes, since a few of them, such as the Lluta, deriving water from the slopes of recently active volcanoes, are charged with noxious mineral matter. Between Pisagua and Copiapó Andean rivers of any kind become very scarce, and but few of those that descend to the coastal strip succeed in finding their way permanently to the Pacific. Yet the nitrate fields and their ports contain between them a quarter of a million inhabitants who depend upon outside sources for almost all their food and even part of their water supplies. In the desert zone of Northern Chile, mining for metals, especially for copper, both in the Coastal Range and in the Andes, provides a source of livelihood for numbers of people in addition to those on the nitrate fields, but the copper mines are not generally in absolutely waterless places.

The high plateau in both Southern Bolivia and Northern Argentina is almost uninhabitable, but a number of the eastern valleys opening on to the Chaco are, as already noted, sufficiently

productive to maintain considerable settlements. Here then, between the parallels of 21° and 27° S., the Andean system acts as a barrier, more or less completely separating two more or less populous zones, a mining zone on the west and an agricultural and pastoral one on the east; whereas farther north, all the way from Central Bolivia to Northern Ecuador, the Andean zone, though still rendering communication between the Pacific coastal plain and the eastern valleys extraordinarily difficult, carries a population and exercises an economic pull sufficient to act as a means of uniting in itself, instead of separating, the two border zones. There are no capitals, past and present, such as Cuzco, Quito and La Paz, in the plateau region between the nitrate fields and the pre-cordilleran zone on the other side of the mountains.

South of Copiapó the Andes gradually contract to a single but relatively broad mountain zone. The distinctive feature of high plateaus disappears and the climate becomes more and more severe with the greater distance from the tropic, so that agricultural settlements are impossible at high elevations and mining centres such as that of the Braden Company at El Teniente are difficult to keep going during the winter. The Southern Andes resemble the inhospitable plateau region immediately north of them in being unable to support any permanent population; as far as 38° S. they also constitute a serious barrier to intercourse east and west. Yet that section of the mountains adjoining the Mediterranean climatic area of Chile, by condensing moisture from the Pacific on its western slopes, supplies streams to the Longitudinal Valley which are widely used for irrigating purposes in the dry zone between Copiapó and Santiago and even for some distance farther south.

From Lake Alumine southwards the Andes are easier to cross than anywhere in their central and northern sections owing to their reduced height and to the numerous passes well below the average level of the chain. Yet the traffic across these passes amounts to very little, since the three southern mainland provinces of Chile contain a comparatively small population, and from the Gulf of Ancud southwards the western side of the mountains is practically uninhabited, while the Patagonian region on the eastern side is but sparsely peopled. The excessive rainfall on the western slopes of the Southern Andes, in fact, balances to some extent the relatively smaller physical difficulties of transit from one side of them to the other, and renders them a distinct regional and natural boundary.

The Longitudinal Valley of Chile between the Andes and the Coastal Range is by no means a simple elongated depression

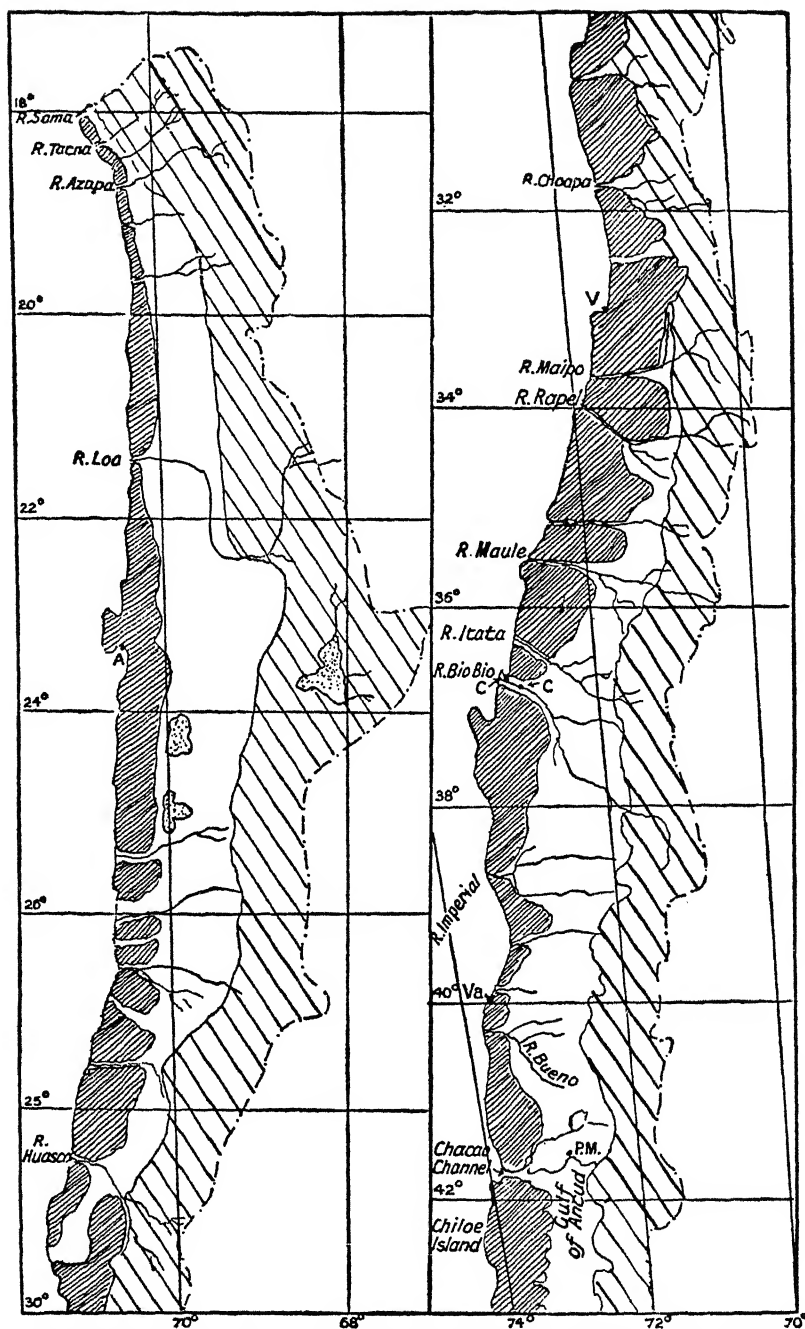


FIG. 45.—The Andes, the Coastal Range and the Longitudinal Valley of Chile
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like the Great Valley of California. For about 500 miles north of Copiapó it is very clearly marked. Its average width here is about 20 miles ; in Tarapacá it widens out to between 25 and 30 miles, but in Antofagasta it contracts noticeably. The most extensive continuous plain in this northern part of Chile is a desert area known as the Tamarugal Pampa, the surface of which is still being raised by material brought from the Andes, just as the whole northern valley has been built up to its present level of 3,000 to 6,000 feet by detritus from the same source.

The Coastal Range, which acts, as it were, as a retaining wall for these high-piled layers of sediments, rises steeply from the coast to a general height of several thousand feet, above which level massifs rear themselves at intervals to upwards of 6,500 feet. In the northern zone the outer range consists of a maturely contoured mountain belt from 30 to 40 miles in width which abuts against the "Pampas" of the Longitudinal Valley along a sharply-defined line. The steep descent to the Pacific contrasts sharply with the rounded outlines of the upper and inner surfaces of the Coastal Range, and is to be ascribed to the relatively recent extensive elevation of the coastal belt along the line of a marked continental fault. For a long period, therefore, the upper part of the range was subject to denuding forces, while what is now its western face was either beneath the sea or (prior to the faulting) was unborn.

In the northern part of Atacama Province low irregular ridges appear in the Longitudinal Valley, and from Copiapó southwards these increase in number and in height until towards the border of Coquimbo Province the whole belt between the Coastal Range and the Andes is occupied by a confused mass of mountains. Between Chañaral and just north of Santiago the Longitudinal Valley scarcely exists, the only indication of a north and south depression being afforded by the valleys of some of the tributaries to the rivers that flow from the Andes westwards to the sea. For some distance north and south of La Serena the Coastal Range has been broken down, but the country behind being above the average height of the outer range, there has been no possibility of the formation of a rock or invasion harbour by the drowning of a valley or an interior lowland area as at San Francisco in California. The whole Chilean coast from Arica to Puerto Montt owes its poverty in good harbours partly to the breadth and the persistence of the coastal mountain belt, and partly to the considerable height, everywhere except south of Valdivia, of the zone just behind that belt.

A few miles north of Santiago there is a saddle some 5,000 odd feet in height, known as the Cuesta de Chacabuco, on the

southern side of which the Longitudinal Valley reappears with a floor elevation of about 2,000 feet. Round a rock fortress founded by Valdivia and situated on the eastern or Andean edge of the Valley, the city of Santiago has been built. Its strategic position has been rendered the stronger by the fact that at Angostura, not far to the south, the Valley contracts to a narrow defile little more than half a mile wide. Beyond this "land strait," as Darwin calls it, the Valley opens out to a width of about 25 miles, only to be contracted into passages similar to that at Angostura, but not so narrow, at two other places within the next 80 miles. Beyond the second of these, the Curicó defile, it continues uninterrupted for a distance of some 400

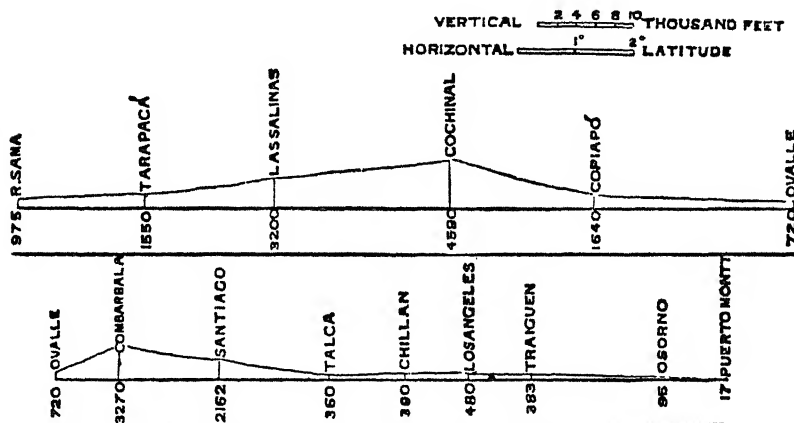


FIG. 46.—Profile of Chilean Longitudinal Valley Region from the Peruvian Frontier to Puerto Montt

miles to Puerto Montt. In this section the Valley falls continuously from the level of about 1,500 feet at Curicó to less than 50 feet in the extreme south, though owing to its great length the fall is not noticeable and some of the tributary streams even flow north against the general dip.

The Coastal Range resumes its strength as a barrier towards the Pacific south of the break in Coquimbo Province, and reaches its maximum height of about 7,000 feet in various massifs in the provinces of Valparaiso and Santiago. South of the Maipo River it begins to decline in height, and beyond 34° S. it never exceeds 4,500 feet on the mainland. Broken completely by the sea at the Chacao Channel, the Coastal Range can be traced, as observed in Chapter I, through the islands and the Taitao Peninsula south to the Straits of Magellan, and beyond that in the mountains

of Tierra del Fuego, where it again reaches a height of nearly 7,000 feet in Mount Darwin and Mount Sarmiento.

Just as the Coastal Range declines gradually in elevation from Central Chile southwards, so it also falls from Antofagasta Province northwards. Beyond the Chilean frontier in Peru various blocks belonging to the Range lie at intervals along the continental coastline and form the northern counterpart of the Chilean islands to the south. The largest of these blocks occurs in Ica Department and causes the coast there to stand out noticeably west of the general alignment of the rest of the Peruvian shore. The structure of the coastal belt in Peru wherever there are fragments of the Coastal Range is almost precisely similar to that of Northern Chile. Whatever depression formerly existed between the Andes and the outer range, has been filled with sedimentary material, so that even near the sea its level is practically equal to that of the Range, and inland is considerably higher. The trenched valleys of the Andean streams in this desert piedmont proceed on evenly graded floors from the cordilleran foothills to the sea, and intersect first the alluvial deposits of the so-called coastal plain and then the hard rocks of the remains of the Coastal Range. The rivers have simply incised their direct courses as the whole marginal belt rose with the recent elevation (see Fig. 42).

We have already seen that permanent rivers are very scarce in Northern Chile as far south as the 28th parallel, but practically all the existing watercourses follow more or less direct lines westwards from the Andes across both Longitudinal Valley and Coastal Range, just as do the rivers of Western Peru. The same feature is observable also in Central and Southern Chile, even in those parts where the floor of the Longitudinal Valley is well below the general level of the crest of the Coastal Range. Chile (and Western Peru to a minor extent) thus provides a striking contrast with the Californian area of the United States where the main rivers flow for great distances along the valleys before turning west into the ocean.

Of the three longitudinal zones, the Andean, the Intermont and the Coastal, that compose the Pacific slope of South America from Central Peru southwards, the first, the Andean, is much the strongest. It persists without interruption, it occupies everywhere at least half the width of the strip between the main divide and the ocean, and fills practically the whole width of that strip in Central Chile (Coquimbo, Aconcagua and Valparaiso Provinces), and in the long mainland section of Southern Chile fringed by islands. The Coastal Range, though vigorous enough between 18° and 42° S., breaks into fragments, as already noticed,

along the Peruvian coast and in the Chilean archipelago region. The intermont zone, represented by the coastal plain of Southern Peru and by the Longitudinal Valley of Chile, nowhere very wide, is liable to become squeezed in places between the two mountain zones, either into the form of very narrow passages or altogether out of existence. Even where the mountain belts are far enough apart to enable it to develop as a fairly wide plain, its surface is liable to interruption by the projecting tops of half-buried hills and ridges belonging to one or other of the mountain systems on either side, particularly to the Andes.

The forces that have raised the Andes in recent times and have caused the simultaneous uplift of the Coastal Range in Chile are still at work, in a subdued form it may be, but none the less quite noticeably. Raised beaches are a conspicuous factor of the shore line along the Pacific, and terraces thought to be of marine origin are found even in the interior at the foot of the Andes. Delightful as the climate and surroundings are in Central Chile, these amenities are offset to some extent by the frequent occurrence of earthquakes, some of which, such as that at Valparaiso in 1906 and those at Concepción and Chillan in 1939, prove very destructive. Between 1907 and 1924, it is said, there were over 12,000 earthquakes in Chile, i.e. at the rate of two per diem. Of these thirty-three, or two per annum, were destructive. The high frequency of these visitations points to the fact that the earth's crust in this marginal zone has not reached a position of stability, for attaining which its situation between the high mountains and the deep sea is most unfavourable. So long as the population was mainly scattered and agricultural, crustal disturbances did not matter much; but when important cities such as Santiago and Valparaiso come into existence, destructive earthquakes are liable to cause serious interruptions in the economic life and progress of the region.

The climatic features of the Western Andes have been described in general outline in Chapter XVIII above. From Arequipa southwards to Central Chile their western slopes contain no settlements other than scattered mining camps and a few oasis-like villages situated at points where snow-fed streams broaden out temporarily and leave alluvial tracts. Some of the latter centres, like S. Pedro de Atacama, are of importance as fodder stations on the long trails over the Andes. In Central Chile, where the Longitudinal Valley tends to be dry, and especially where the Andes advance towards the coast, settlement in following the more abundant water supplies has pushed up the valleys of the main mountain system. In Southern Chile, on

the other hand, the mountain country is avoided, because of the excessive rainfall, the torrential nature of the rivers and their liability to flood, and because of the thin cover of soil in the districts not occupied by a drenched forest tangle. The paucity of the population throughout the whole dry middle section of the western slopes of the Andes in Peru and Chile is due not only to the shortage of water, but also to the fact that the mountains are generally so precipitous as to render it impossible to utilize the rivers for irrigation, even by means of the terracing method common elsewhere in the Andes. There are few places where the rivers pause sufficiently in their downward courses to enable soil to accumulate. They generally flow swiftly from leap to leap in deep ravines. It is a curious comment on the situation of the oasis settlements in the Western Andes that, though they suffer from time to time through lack of water in their supporting streams and through failure of their average scanty rainfall, their worst enemy is floods, which either sweep away the inhabitants' crops and belongings, or still worse, strew their fields with thick layers of pebbles and debris brought down from the mountains above.

In Southern Peru and Northern Chile the desert is universal below elevations of 10,000 feet up the Andes except in the few irrigated valleys.¹ In Southern Chile, on the other hand, permanent settlement is impossible above 6,000 to 7,000 feet because of the severity of the climate rather than because of scarcity of water. Owing to its great extension in latitude, and still more, by reason of the Andean wall on its eastern frontier, Chile contains within its boundaries, even along the Pacific shore, the most striking contrasts possible. The average rainfall at Iquique is less than a twentieth of an inch per year, that at Puerto Montt over 100 inches, while on the western slope of the Andes facing the Archipelago region it is over 200 inches. The alternation of fog and bright sunshine in the region of the nitrate ports gives place to almost constant sunshine in the Copiapó district, where the rainfall of under an inch per annum is still very low. Six degrees farther south at Valparaiso the rainfall amounts to 20 inches, but is confined mainly to the winter months (see Fig. 6). As one proceeds inland from that town the annual precipitation declines at first in the Longitudinal Valley (it is only 14 inches at Santiago), but increases afterwards up the slopes of the Andes, just as it does everywhere else from Panama to the Straits of Magellan. Southwards from Valparaiso the

¹ On the Andes behind the Atacama region xerophytic vegetation begins at 10,000 feet, and is replaced by grasses between 12,000 and 15,000 feet.

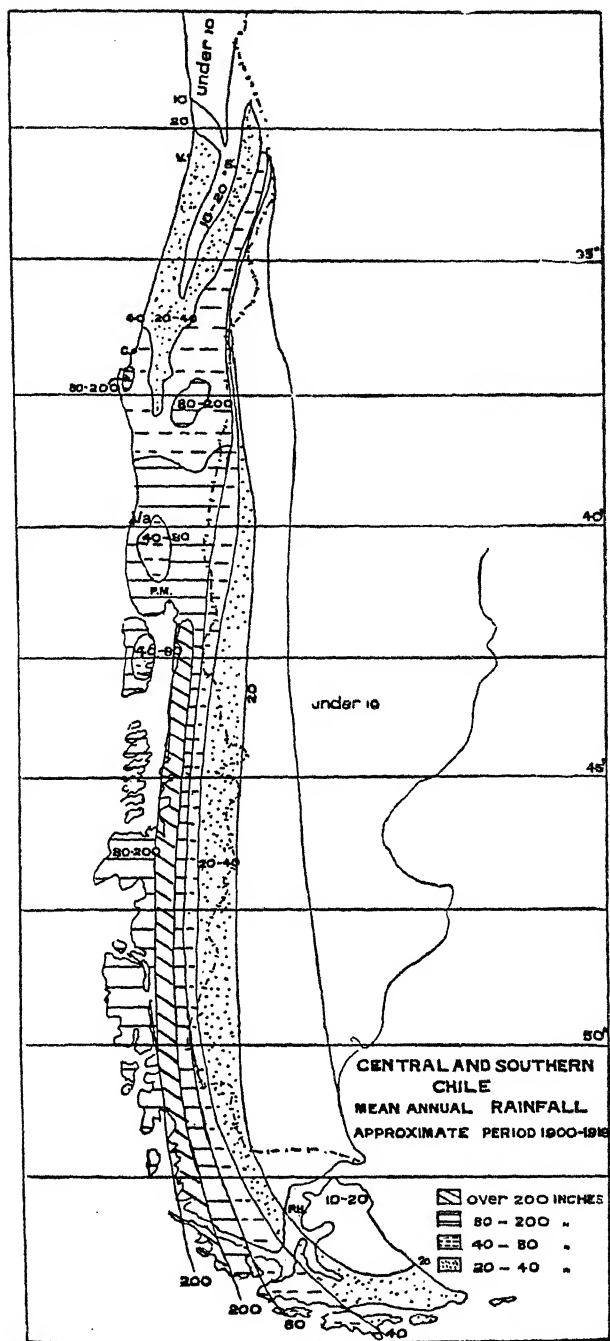


FIG. 47.—Rainfall Map of Chile

rainy season increases steadily in length and the rains become heavier and more frequent, never to diminish again in Chilean territory except in that part of the Magellanes area which lies east of the western mountains. The rainfall map of Chile (Fig. 47) shows the peculiarities of distribution in all those parts of the country which receive any moisture worth recording.

Though tropical in latitude, Northern Chile has a relatively cool climate even at sea-level on the coast. Inland the surface relief rises rapidly, as already seen, and the greater elevation is at least sufficient to compensate for the declining influence of the cool breezes off the Humboldt current which prevent the shoreline strip of both Southern Peru and Northern Chile having an average annual temperature corresponding to their latitude and their lack of rain. In Central Chile even the Longitudinal Valley, when it reappears just north of Santiago, lies at an appreciable elevation, and the actual temperatures are therefore kept down by this factor as well as by the cool winds from the Pacific. The dry summer season, the influence of the Coastal Range in intercepting clouds and sea-mists, and the elevation of the surface above the sea, combine to give the district round Santiago and some distance south of it the pleasant and invigorating climate for which it is famous. The amenities of the region are increased by the way in which streams from the Andes descend into the Valley and meander across it till they break through the outer range on their way to the Pacific. More than two-thirds of the population of Chile, and much the most influential section politically, lives in a narrow zone extending north and south some seven degrees of latitude between Coquimbo and Concepción, but this is less than a fifth of the entire length of the country.

The natural vegetation of the Andes and of the Pacific slope from Central Peru to Tierra del Fuego is on the whole scanty. The high mountains and plateaus, as well as the coastal strip down to the latitude of Central Chile, support little plant life except the scattered moss-like yareta bush and the ichu grass of the Peruvian and Bolivian Andes, and ribbons of chaparral and scrub along the water-courses to the coast. In the deeper valleys of the eastern part of the mountain zone and on the more favoured parts of the plateaus the conditions are better suited to vegetation. Crops are cultivated, as already noted, on the valley floors; patches of thin forest occur in favourable places on the valley sides; while the high-lying pastures of the Peruvian Andes, most abundant in the region situated north of Lake Titicaca, support some 5 million sheep in addition to large numbers of llamas and alpacas.

On the hills and mountain slopes of the Coastal Range along the arid zone of Western South America showers are experienced from time to time, very rarely north of the Tropic of Capricorn, with increasing frequency as one travels southwards from Copiapó to La Serena, and these give rise to temporary pastures. Similarly also, the almost rainless western slopes of the Andes between Lima and Copiapó give place to less arid slopes south of the latter town which provide thin pasture in places. The transition from marked aridity to conditions more favourable to grasses is reflected in the figures of the live-stock in the Chilean provinces of the zone. Cattle, sheep and goats together amount to less than 16,000 head in Antofagasta Province, but rise to 78,000 head in Atacama, and to about 725,000 head in Coquimbo.

In the Mediterranean region of Central Chile scattered forests appear. These consist largely of various species of beeches and laurels, together with a kind of cypress. Most of the timber has been cut, however, in the course of the four centuries of settlement, and the greater part of the fertile and sufficiently watered land is devoted to pastures and crops. The real forested zone of Chile begins in the provinces of Linares and Maule and continues thence southwards to the Straits of Magellan, where natural pastures predominate on the lowlands east of the mountains. The most valuable forests occur in the mountain section up to 5,000 feet extending from Linares to Llanquihue, and particularly in Malleco, Bio Bio and Cautin, where Chilean pine (*Araucaria imbricata*) is fairly abundant. Elsewhere throughout these Chilean forests the stands consist, as they do farther north, mainly of beech, laurel and cypress, but with additional species and a richer undergrowth. With the wide range of latitude and climate between Linares and Magellanes there is a natural substitution of one species by another towards the south, where Antarctic beech is the characteristic tree.

The Chileans have recently been making vigorous efforts to develop their forest resources and to render themselves less dependent upon foreign supplies of timber. It is true that the forests still standing are sufficient to meet the country's requirements at present, and may even provide some surplus for export to Argentina. On the other hand, most of the more valuable trees, and *Araucaria* in particular, grow very slowly, so that when the more accessible stands are cut there is little probability of replacement. Much of the now remaining timber is in places difficult to get at, and the heavy rains of the forest country interfere with cutting operations for more than half the year. The timber when put on the market tends therefore to be costly and to be poorly seasoned. As the population and the timber

requirements of the country increase, it is doubtful whether local supplies will remain sufficient to meet the home demand, still less to furnish a surplus for the export trade. In inter-war years Chile was on the balance a very small importer of wood, but this was due rather to the dislocation caused by the European War and to heavy protective duties than to wealth of forest resources.

The three leading industries of the coastal strip from Lima to Puerto Montt—namely, agriculture, stock-rearing, and mining—show a fairly definite zonal distribution. In the irrigated valleys of Peru, which extend south into Tacna Province, agriculture holds the field. In addition to cotton and sugar, various food crops, including cereals, fruit and vegetables, are grown not only for local consumption but also for export to the nitrate pampas which draw supplies from points along the coast all the way north to Lima and all the way south to Concepción. In the arid region comprising the Chilean provinces of Tarapacá, Antofagasta and Atacama, agriculture and stock-rearing are possible only in a few oasis areas; and mining, not only for copper in the high Andes (see pp. 247-248), and for nitrates in the Longitudinal Valley, but also for copper again in the coastal mountains, is the one and only industry. In the transitional climatic region in Coquimbo and Aconcagua Provinces the rearing of live-stock, especially of goats and sheep, tends to assume the first place among the industries, and the mining of copper and iron in the coastal mountains and of copper inland, the second place. In the populous heart region of Chile the cultivation of the soil definitely becomes the leading industry. There sufficient quantities of wheat and barley are raised to furnish something for export after meeting the needs of the whole country; and in addition, considerable supplies of wine, fruits and miscellaneous fodder crops are produced. There also the pastoral industry occupies a place of importance, all three classes of animals, cattle, sheep and goats, being reared on the hill and valley pastures. The mining industry, so marked in Northern Chile, disappears almost completely, except in the form of coal-mining, in the central and southern parts of the country. In the wet zone of Southern Chile agriculture is limited to the cultivation of such crops as oats and potatoes, and stock-rearing and dairying occupy the chief attention of the people.

From Chiloe Island to 53° S. there is an uninhabited gap on the western side of the Andes, but in the extreme south-eastern part of Chile, in the region adjoining the Straits of Magellan, lies an area devoted almost exclusively to sheep-rearing. Magellanes Territory, thanks to the broad plains in the lee of the mountains,

contains nearly half the sheep in Chile, and (at Punta Arenas, for a time called Magellanes) the only group of freezing works in the country, whence in recent years over a million carcasses per annum have been exported.

The limited areas available in Chile for agriculture and stock-rearing render it impossible for the country ever to vie with Argentina as a source of cereals and animal produce. In respect of cattle, Chile, in fact, imports many more animals than it exports, and there is no likelihood of a surplus becoming available for the refrigerated beef trade. The prospects are not much better in regard to wheat. In normal years the exports of that grain from Chile exceed the imports, but the margin is a small one. The surplus of barley, oats and beans is both larger and more certain, and in the first of these three products Chile is one of the more important minor sources of supplies in international trade. Honey, too, is sent from the country in considerable quantities, and an export business in fresh, dried and tinned fruit seems likely to develop. In more ways than one, in climate, in physical setting, and in facilities for irrigation,¹ Central Chile is the Southern Hemisphere counterpart of California, and natural conditions will lead it towards specialization in similar types of agricultural and horticultural industries.

Mining in its various forms has for centuries stood in the front rank of Chilean industries, and in respect of the product is now of greater absolute importance than ever before. Chile, as is well known, supplies the world with natural nitrates and with iodine. It stands second among all copper-producing countries.² It is the only country in South America that till recently exported iron ore in large quantities,³ or that raises coal from its own mines on any notable scale.

The early history of mining in Chile, as in other countries of Spanish South America, is associated with the search for gold and silver, but these metals do not occur so abundantly there as farther north in the continent, and the present output is relatively quite small. Copper next attracted attention, partly because of

¹ The total area of irrigated land in Chile is 3 million acres, that in California over 6 million acres.

² The smelter output of copper from Chile in 1943 approached 500,000 tons, representing 18 per cent. of the world's supplies, against over 35 per cent. from the United States. The other chief producing countries in order were Canada, Rhodesia, Belgian Congo, and Peru.

³ From the Tofa Mountain, 4½ miles from the coast in Coquimbo Province, the Bethlehem Steel Corporation of America was, prior to 1940, extracting the ores and shipping them at the rate of 1½ million tons a year to the United States. Exports in 1955 amounted to 1½ million tons.

the readily available resources in soluble oxidized ores at or near the surface in the Coastal Range in the arid region. When these became worked over towards the close of the nineteenth century

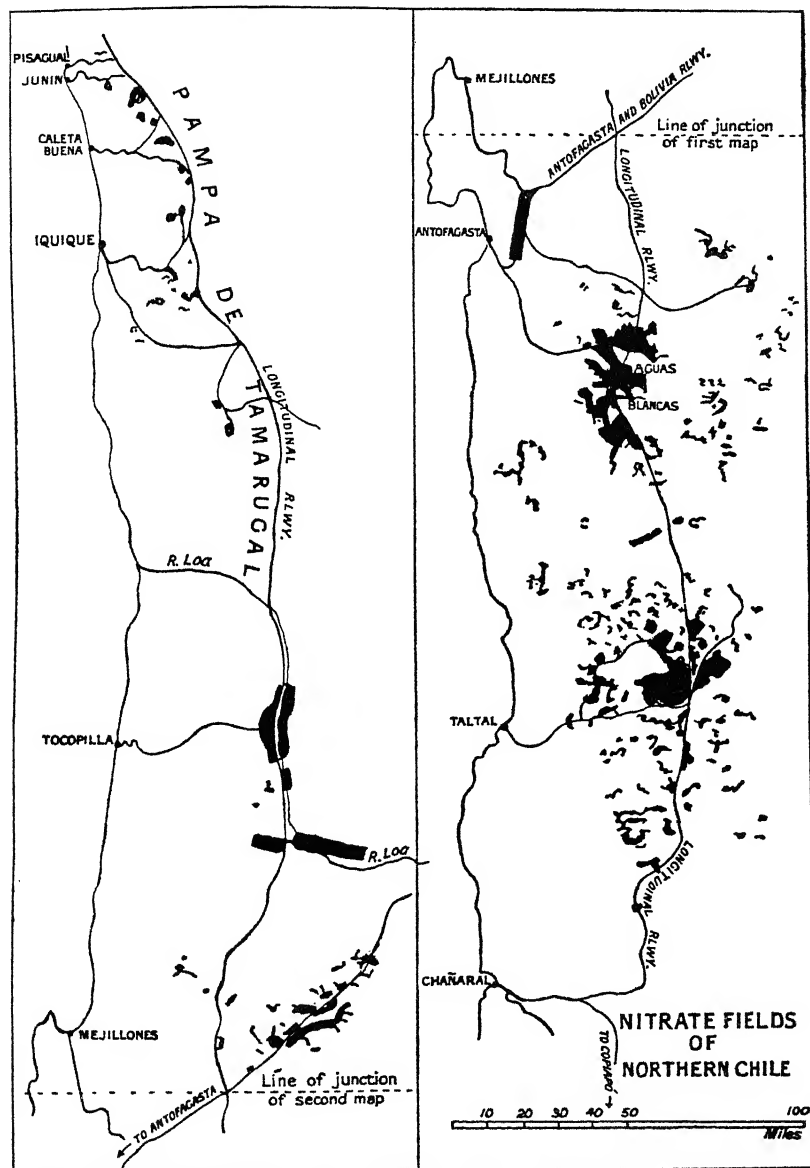


FIG. 48.—Nitrate Fields of Northern Chile

Chile ceased to be the leading copper-producing country it had been throughout that century; and it is only quite recently, with the application of large sums of capital and the laying down of special plants (see p. 248) to work the huge deposits of unoxidized low-grade ores in the Western Andes, that copper mining in Chile has revived. The quantities of the metal now obtained from the Coastal Range in Antofagasta, Atacama and Coquimbo Provinces are small compared with those from the great Andean mining centres at Chuquicamata, Potrerillos, and El Teniente.

The nitrate industry has been prominent not only among the mining activities, but also in the whole economic life of Chile. Nitrates have furnished a leading item in the export trade of the country, and the 25 per cent. Government share of sales proceeds (substituted in 1933 for export taxes) represented a substantial part of the state revenues. The export trade in nitrates began in 1825, when 1,000 tons were exported. Between 1830 and 1900 the output doubled every ten years. Its rate of expansion

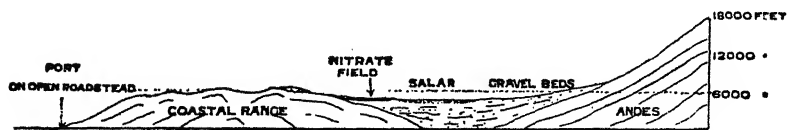


FIG. 49.—Diagrammatic Section showing Occurrence of Nitrate Fields in the Latitude of Taltal

Horizontal scale: 1 inch = 23.3 miles.

Vertical scale: 1 inch = 30,000 ft. = approx. 4 times horizontal.

slackened a little with the opening of the twentieth century, but the exports in 1913 amounted to nearly $2\frac{1}{2}$ million metric tons compared with just over 2 million metric tons in 1908. The war of 1914-18, though it brought temporary prosperity to the industry, was in reality the indirect means of placing it in a very critical position. In no year between 1918 and 1925 did the exports reach the 1913 figure and by 1936 they were down to less than half that figure. The manufacture of synthetic nitrates in Europe and North America which had begun before 1914 had been greatly stimulated by the war, and synthetic products are now very serious competitors. The quantities of these substitutes annually produced are increasing rapidly, and per unit of nitrogen they tend to be cheaper than the Chilean natural product. In the first half of 1926 the Chilean industry was faced with a slump in the world's demand for nitrate of soda, and steps were taken, which at the time proved ineffective, to induce the Chilean Government to reduce the duties. The exports recovered in the years 1927-29, but have since declined heavily. (See p. 289.)

Various theories have been put forward to account for the formation of these Chilean deposits of nitrate. It is clear enough that the arid climate is one of the necessary conditions, otherwise the soluble salts would soon be washed away into the sea. Since the caliche or nitrate-bearing material is found on the margins of salars or salt-encrusted basins in the lower part of the longitudinal depression, but at a somewhat higher level than the common salt, it appears that nitrate, after being carried with the other salt by percolating waters into that part of the depression adjoining the Coastal Range, has then been redistributed by efflorescence. The caliche usually occurs several feet below the surface and naturally varies a good deal in the percentage of nitrate it contains.

With regard to the future, the most authoritative estimates of the reserves still remaining seem to agree in placing them at not less than 300 million tons, which would last for more than two centuries at the present rate of removal. Since much of the ground has not yet been carefully surveyed, the total effective reserves are probably not less than 600 million tons. On the other hand, the supplies of high-grade caliche are disappearing and the cost of production is becoming a serious matter. Under the methods of extraction common in the oficinas till recently the percentage of nitrate recovered was much lower than was technically possible. Thus the best hopes for the Chilean industry as a whole lies in the direction of reducing costs by improvements in the processes of extraction, which have been introduced as noted below.

Iodine is one of the constituents of the nitrate-bearing caliche, and is readily removed in the course of the treatment of the latter in the oficinas. With exports averaging about 1,000 tons per annum, Chile contributes two-thirds of the world supplies, and therefore has a semi-monopoly of production. Since the caliche which is treated every year contains more iodine than is required to meet the world's demand, the various nitrate companies are limited to a certain quota of output in order to avoid over-production. Thus Chilean nitrates, as marketed, contain a small percentage of iodine which is absent, of course, from the synthetic products, but which is a valuable element in the fertilizer, especially for cotton crops. Indeed, it appears that the Chilean nitrates owe much of such favour as they retain in competition with the synthetic nitrates throughout the world, to the valuable effects of the small quantities of iodine left in them.

Coal-mining in Chile is confined to the provinces of Arauco, Concepción and Valdivia, and to a small district near Magelanes. The deposits are neither extensive in area nor contain

country, nor in the cost of power since waterfalls are being rapidly harnessed, but in the shortage of labour, the supply of which is insufficient for existing industries. Chile does not attract a steady flow of European immigrants as does her great agricultural neighbour Argentina.

Along the whole desert strip from Lima in Peru to Copiapó in Chile there are hardly any even small-sized towns inland from the coast. In Peru and in Tacna Province the whole traffic of the river-oasis strips concentrates in the ports at their seaward terminus. In the mining region of Northern Chile the same situation holds *mutatis mutandis*. The nitrate ports strung in file along the coast—Pisagua, Caleta Buena, Iquique, Tocopilla, Mejillones, Antofagasta and Taltal—have simply arisen at points where the best anchorage could be found to serve as outlets for the mineral wealth of the desert directly behind. Where the desert begins to give way to less arid country at Copiapó, the port becomes secondary to the inland centre: Caldera is smaller and less important than Copiapó, Valparaíso than Santiago and Constitución than Talca. Only in the southern part of the mainland section of the country, where the rivers are large enough to provide some sort of shelter for ships, do the ports such as Concepción and Valdivia overshadow the agricultural centres in the Longitudinal Valley.

It has been noted already in Chapter I that the Peruvian-Chilean coast as far as 42° S. is poor in harbours. Even important railway terminals like Mollendo, Arica and Antofagasta stand on open roadsteads, and the nitrate ports pure and simple are no better off. It is true that they are situated in a zone where on-shore winds are relatively weak and they thus escape the worst effects of their exposed position. Yet all cargo has hitherto had to be transferred by lighters between ship and shore and vice versa. Valparaíso, though sheltered from the south-westerly and westerly winds, was dangerously exposed to north-westerly gales until recently when a large breakwater was completed. Two of the ports in Southern Chile, namely Talcahuano and Puerto Montt, are exceptional in having reasonably good accommodation for vessels, but the former has been reserved as a naval station, and the latter is inconveniently situated at the southern end of the Longitudinal Valley with a morass for its immediate hinterland.

Nevertheless both Chile and the coastal region of Peru have to rely to a very large extent upon shipping, not only for intercourse with the outside world, but also for communication between one point and another along the narrow strips adjoining the Pacific. There is no longitudinal railway in Peru and the

freights on that in Chile are too high for long-distance traffic. The improvement of the ports and of their connections with the interior is therefore of outstanding importance in the further development of both Chile and Coastal Peru. In Chile the Government has taken matters in hand; large new construction works have been completed at Valparaíso and at San Antonio, 40 miles to the south of Valparaíso, and 21 miles nearer to Santiago by railway. The Government's programme includes also the modernizing of Antofagasta and Arica harbours and costly port works at Lebu, an outlet of the Arauco coalfield. The last-mentioned town is to be linked by means of a line via Los Sauces and Traiguén with the Longitudinal Railway at Puá, and when the connection thence over the Andes with Zapala is completed, Lebu will become the Pacific terminus of a broad-gauge railway crossing the continent to Bahía Blanca (see Fig. 50).

The Chilean railway system began with various independent and mostly private lines working inland from the ports, and this accounts for the bewildering multiplicity of gauges in the country.¹ The state-owned Longitudinal Railway came later, but even this has been built on two different gauges, the metre gauge in the northern section and the broad gauge in the southern. Altogether, the completed longitudinal system from Pisagua to Puerto Montt represents a *tour de force*. It has been constructed for nationalist and strategic reasons rather than in the expectation of its getting sufficient traffic to pay its way. The nitrate export taxes, in fact, have enabled the Chilean Government to build this trunk system and to keep it running at a loss.

Owing to the interruption of the Longitudinal Valley by mountains in Coquimbo and Aconcagua Provinces the railway, after reaching the coast at La Serena, has to thread its way by a very devious route and over numerous inconveniently high mountain spurs before reaching Quillota, the junction of the lines to Valparaíso and Santiago. The construction of the southern section, moreover, in Cautín, Valdivia and Llanquihue Provinces proved very expensive owing to the marshy nature of the ground and the numerous rivers that had to be bridged.

Now, however, that a state-owned line has been completed throughout practically the whole length of the mainland area of Chile, the country has two lines of communication uniting the populous and compact central zone with the thinly peopled and less securely attached northern and southern zones. The sea, as already observed, is the more serviceable highway, but should communication be interrupted there, it will still be possible to

¹ The Chilean railway gauges include the following: $2\frac{1}{2}$ feet, metre, $3\frac{1}{2}$ feet, 4 feet 2 inches, and broad gauge (5 feet 6 inches).

fall back on the railway, protected almost everywhere by the Coastal Range that lies between it and the sea. In this respect Chile is much more fortunate than the coastal strip of Peru whose isolated ports are strategically in a very weak position.

With the development of motor road transport and aviation two other longitudinal transport systems have been established along the coastal zone of Peru and in Chile from Iquique to Puerto Montt. The so-called Pan-American highway has been constructed throughout the length of Peru via Trujillo, Lima, and Pisco, linking at Tacna with the Chilean longitudinal highway more or less completed to Puerto Montt; and in addition to the Pan-American international airlines terminating southward at Santiago, both Peru and Chile operate frequent local air services from their respective capitals to the northern and southern regions of their territories.

NOTE ON RECENT DEVELOPMENTS IN THE CHILEAN NITRATE INDUSTRY

With increasing difficulties due to declines in prices and sales, the industry was reorganized and nationalized from 1933 onwards when the Nitrate Sales Corporation was set up. The former numerous small oficinas have been largely replaced by three large enterprises whose plants have a combined capacity of about 1.6 million tons, and can treat caliche down to 7 or 8 per cent. content, and recover up to 85 per cent. of the nitrate. The Government retains its 25 per cent. share of the profits of the industry which, however, in 1940-45 exported only about 1.5 million tons of nitrates per annum, representing about 8 per cent. of the world output of natural and synthetic nitrates. A stabilizing agreement made with the producers of synthetic nitrates in North America and Europe broke down in the second Great War, and since 1945 Chilean exports have on the average only just held their war-time level. According to informed authorities the Chilean industry has a doubtful future.

NOTE ON PAN-AMERICAN HIGHWAY

This ambitiously planned intercontinental "carretera" is now completed, most of it all-weather serviceable, from North and Central America to south-central Chile and across the continent to Buenos Aires; thus in South America it links up the four Pacific republics and the heartland of Argentina.

After threading the Colombian-Ecuadorian Andes via Medellin, Pasto, Quito and Loja, the Highway descends to the Peruvian coastland. Thence south of Lima, except for the detour into the Andes through Arequipa, it follows the depression between them and the Coast Range for 1,500 miles to Santiago. As an international highway its practical value falls short of its imaginative appeal; but it does serve with its side branches to provide connections by motor transport between many places within the several countries, that were previously more or less isolated from one another.

CHAPTER XXII

GENERAL SURVEY OF ECONOMIC CONDITIONS IN SOUTH AMERICA

The Outlook for the Future

THE course of the development of any region is determined by three major factors, climate, physical and geological structure, and the character and aptitudes of the people that inhabit it. Of these three factors the most important is climate taken in its widest sense, since it influences the others. Striking as the climatic conditions are in influencing the development of regions that have long been the home of populations which have reached a relatively advanced state of civilization, they exercise a still more decisive force in what happens in distant areas settled in later times by Europeans. The new arrivals in these places usually have to depend more exclusively upon agricultural industries for their living and progress, than do the people they leave behind them; and they are unable, in the early stages at all events, to supplement nature's deficiencies by means of such products of human ingenuity and experience as irrigation works, useful plants and animals selected and bred with a special view to adaptation to the peculiar conditions obtaining, and methods of cultivation that utilize to the utmost the productive capacity of the soil within the limits set by climatic peculiarities, known intuitively rather than consciously by long-settled agricultural populations.

Only in very limited parts of South America did the Spaniards or the Portuguese find climatic and physical conditions resembling those with which they were familiar in their European homes. It is a striking fact that the former in the early stages of their establishment on the mainland relied in no small measures upon food stores brought from the West Indies and even from Spain. The economic conquest of South America would have been much easier for Europeans had they found on their arrival there, as they had done in Asia, native populations advanced to a sufficiently high stage of civilization to have learned how to utilize the productive capacity of the soil in the tropical areas. But

the New World was poorly provided with useful plants and animals compared with the Old, and throughout the really tropical parts of it the natives had no fund of experience in turning natural resources to productive uses, that could be appropriated by the Europeans.

Thus, on their arrival in South America the Spaniards and the Portuguese had to start at the beginning everywhere, except in the high plateau of Peru, in winning produce other than minerals from the soil. Like their predecessors, the native Indians, they were at first very much the slaves of nature; they had to utilize whatever resources the climate and soil provided at first hand; they overran the continent rather than occupied it; they had neither the capital, nor the experience of new conditions, nor the aptitude for making experiments or for subduing the unwonted environment. The hot, unhealthy lowlands of the tropics, whether forested or open, swampy tracts wherever they occurred, semi-arid lands even if capable of irrigation, and places far inland and remote from lines of communication and of military protection, came alike to be avoided by the European as settler in this the first of the outlying continents to be conquered and held by whites.

Compared with North America the southern continent has presented remarkable obstacles to effective occupation and settlements by Europeans in all parts but those south of the Tropic of Capricorn. The vast temperate forests of North America checked for some time the expansion of the Atlantic coastal settlements into the interior, but the temperate forest can be removed with comparative ease, and once removed, it does not grow again. The tropical forest of South America is a different thing. It is difficult to clear, and in most places springs up quickly again. It induces an easy-going and fatalistic outlook in the people who have to contend with it. The luxurious vegetation has not been the only obstacle to progress; the hot and enervating climate of the lowlands of South America nearest to Europe, the lofty and inhospitable mountain plateaus in the west and the desert that separates them from the sea, and the vast areas of swamp in the basins of the great rivers of the continent, have also contributed to rendering the rapid development of South America impossible.

The difficulties that beset Europeans in the sixteenth century in their settlement of the northern tropical and larger part of South America remain in a large measure with their descendants at the present day. Comparatively little progress has been made by the people themselves except perhaps in Eastern Brazil. In Argentina, Chile and Uruguay on the other hand, where the

European has found a more congenial environment, where the natural obstacles to development are less formidable and where the original native population was small in numbers but vigorous in character, remarkable progress has been made since an active and world-felt demand arose in Europe for pastoral and agricultural produce. The people of Argentina and Chile in particular seem to be fired with something approaching the American enthusiasm for material progress, and in this direction have gone a good deal further than the Spanish people in Europe whence they have sprung. From them and also from the people of eastern Brazil, the inspiration and the will to subdue the obstacles which Nature has set to man's endeavour in tropical South America, are spreading to the inhabitants of other republics, but the tasks ahead require large investments of capital combined with technical skills, neither of which South American countries can as yet supply sufficiently themselves; and as they are mostly suspicious of foreign capitalistic intrusion, progress may lag on projects.

The Special Difficulties in South America, mainly in Tropical South America

In the historical survey given in the third chapter above, some of the peculiar social and economic hindrances that have operated to check the rate of progress in South America were touched upon. It is now proposed to examine these and others as they exist at the present time, more especially in their relation to changes and movements that may serve to dispel them. These disabilities may conveniently be summarized under the following heads: the character and low standards of living of the peoples; the weakness of governmental institutions; the burdens imposed by distances and the difficulties of communication; the lack of interest in the tropical regions shown by the outside world during the nineteenth century and till recently; the shortage of fuel: and the unintelligent exploitation of resources without thought for the future. These will now be discussed in order.

I. THE CHARACTER AND COMMONLY LOW STANDARDS OF LIVING OF THE PEOPLES. In two of the republics, Bolivia and Paraguay, the population consists almost entirely of Indians, and in Peru, Ecuador, Colombia, Venezuela and the Guianas the whites are very much in a minority. In all of these states, except in Venezuela and the Guianas where negroes are numerous, Indians and mestizos compose three-quarters or more of the population. In Brazil the races are exceedingly mixed, pure whites forming a small proportion of the entire nation. Thus

neither in blood nor in habits of thought has the europeanization of the people throughout tropical South America gone very far.

One of the characteristics of both Indians and negroes is their ignorance and neglect of hygiene. Their birth-rates are high, but so also are their death-rates, and this accounts in part for a comparatively slow increase in the population of tropical South America till recently. Neglect of hygiene has contributed to a lack of bodily and mental vigour, pre-conditioned by the unhealthiness of the climate in the lowland areas and the prevalence of deadly fevers there, the scattered distribution of the population and the lack of medical service, and the fondness of the people generally for cane-spirit which is only too easily obtainable wherever the climate is warm enough for the sugar-cane to grow. Fortunately, in recent years tropical medicine has made great strides, and no continent is likely to benefit more from the results of scientific progress in this direction than South America. Fever has been banished from a number of the tropical coastal towns formerly infested with it. One of the severest checks that has operated since early colonial days against the increase and well-being of the people of inter-tropical South America has, in fact, been largely removed, resulting in a notable increase in population in recent years.

Whether the passivity and the economic inertness of the Indian will disappear in time as he comes more and more into contact with the white man's methods of attacking nature, is uncertain. The best hopes so far as racial elements in the tropical republics are concerned seem to lie with the mestizos, apart from the pure-blooded Europeans whose numbers tend to decline as intermarriage with the former proceeds. The mestizos, already numbering upwards of one half of the population in several republics, have the advantage of being able to assimilate the white man's civilization based on science, while preserving powers of adaptation to the peculiar climatic and physical environment. There appears very little hope for the future of the negroes in Brazil and in the Caribbean states. They are likely to become an ever-declining factor in the social and economic life of the continent.

II. THE WEAKNESS OF GOVERNMENTAL INSTITUTIONS. Instability of government is one of the worst handicaps to the development of a country in the modern world, where progress and prosperity depends essentially upon credit. All the tropical republics of South America have had their share of political disturbances which have rendered property insecure, have hindered the internal accumulation of capital and have kept foreign investors at a distance. In recent years, however, with

the development of modern forms of transport serving as unifying forces, and with the growth of a spirit of nationhood and of a common loyalty, revolutionary outbreaks have become less frequent and steadily less successful. Corruption and favouritism are by no means banished from either public or private life, but certain minimum standards of consistent and straightforward dealing are gaining ground, with the result that foreign, mostly North American, capital is beginning to flow for development purposes into the hitherto somewhat neglected outlying tropical areas of South America.

III. THE BURDENS IMPOSED BY DISTANCES AND BY THE DIFFICULTIES OF COMMUNICATION. One of the striking features of the economic life of the greater part of South America till towards the close of the nineteenth century, was the high proportion of the none too abundant labour forces, that had to be employed in the task of transferring goods from one place to another. Roads were poor or non-existent, horses could not be used either on the steep trails up the mountains or on the high plateaus or on the wet tropical lowlands, great distances separated inhabited places in the elevated regions in the interior, and the inevitable specialization in mining in some parts, in stock-rearing in others and in tropical cultivations on the hot lowlands necessitated a heavy movement of supplies between one specializing area and another. Human porters were common enough in the elevated mountain mining centres, and even where beasts of burden could be used the number of attendants required was high compared with those wanted for wheeled traffic.

The effects of these drawbacks were, firstly, to place severe limits upon the labour available for purely productive purposes, and secondly, to restrict commerce, except in cattle which transported themselves with a minimum of attendance. Agricultural and pastoral centres at all removed from the sea slipped into a self-contained and unprogressive type of existence—a state of affairs which, reinforced by the conservatism and backwardness of Indian blood, has left as its aftermath a certain inertia and lack of enterprise in the people.

During the fifty years from 1880, and especially between 1900 and 1930, railways were extended into what had been for centuries remote and isolated districts, with the result that these are beginning to be transformed by the commercial movements of the outside world. The more progressive Governments which could command a greater credit with foreign capitalists than they formerly did, have been pushing their railway systems farther and farther into their outlying territory, and so making it possible to transport produce on an increasing scale to the ports. Unfor-

tunately, freights are often at present very high for long-distance hauls, owing to the small amount of traffic available, but this disadvantage is not likely to be permanent. In the meantime, as labour is released from transportation work pure and simple, development work, that was formerly out of the question, can be attempted in the interior.

IV. THE LACK OF INTEREST IN THE TROPICAL REGIONS SHOWN ON THE PART OF THE OUTSIDE WORLD TILL RECENTLY. During the eighteenth century the nations of Western Europe were keenly interested in the tropical areas within their reach as sources of sugar, tobacco, spices and similar articles. For one or another reason this interest waned in the nineteenth century when Europeans busied themselves with exploring and developing the great temperate outlying regions of the world. That task was practically completed, so far as new fields were concerned, shortly after the year 1900. The large industrial populations that arose in Europe and North America owed their existence and their relatively high standard of living to the abundant and increasing supplies of food and raw materials forthcoming from the newly opened temperate lands. Now they are casting round for supplementary supplies of these commodities from the tropics, whose turn for active development appears to be coming again.

Thus, while during the nineteenth century much of South America, being tropical, counted for little in the economic affairs of the world, now in the twentieth its products are coming into foreign demand, with the result that the capital and the scientific knowledge of the most advanced nations tend to be attracted thither. So long as a region can supply nothing that is very much wanted, its credit stands at a low ebb, but when the wheel of fortune brings its produce into request, its status in the eyes of business men and financiers becomes much sounder. In the northern republics, however, there is a tendency for those who supply the capital to work the undertakings on the concession system and on their own account without the local population taking any part otherwise than in supplying labour. By this means resources are vigorously developed, but in extra-territorial enclaves, as it were, from the economic standpoint of the South American countries concerned. This sort of thing is not confined to the purely tropical parts of the continent. The freezing works in Argentina and Brazil, the great copper mines in Chile and Peru and even a large part of the sheep-farming in Patagonia have been worked by foreign syndicates as their personal affairs.

V. THE SHORTAGE OF FUEL. Rich in almost every other mineral, South America is poorly provided with coal deposits. Those which have so far been discovered are few and yield fuels

of inferior quality ; and there is little likelihood from the geological evidence of considerable and rich deposits being found in the future. In discussing the mineral resources of the Andes in Chapter XIX above, reference was made to the fact, that from the beginning of the colonial period till the present day the minerals won from the mines have been exported with a minimum of elaboration in South America itself. In the absence of suitable fuel for smelting purposes this has necessarily been the course adopted not only in the Andean region, but throughout the continent, wherever ores or alluvial gravels and sands have been exploited for minerals.

The poverty of South America in coal has had further effects. Whereas in other newly settled continents, such as North America and Australia, where valuable coal deposits were found, manufacturing industries besides metallurgical ones have established themselves with comparative ease, in South America these industries were almost entirely absent till a generation ago. The continent as a whole was compelled to devote its attention to the production of raw minerals and agricultural and pastoral produce in competition with rich mineral-bearing regions opened up one after another in other more accessible parts of the world, in competition with vast temperate areas in other continents, and with highly organized tropical plantations, supplied with cheap labour, in Southern Asia and the East Indies. The period of intense competition in the supply of food and raw materials to the international market appears to be over, but as long as it lasted, the South American producer, unskilled in modern developments and out of touch with the outside world at large, was distinctly at a disadvantage.

The war of 1914-18 seems to have marked the turning-point in movements in South America for which the ground had been in course of preparation for some time previously. Petroleum has been discovered in various parts of the continent—in Peru, Venezuela, Argentina, Ecuador and Colombia. From the first two of these countries, in fact, large quantities of oil are now exported after meeting local requirements. Moreover, it appears that petroleum exists in the interior of the continent along the eastern foot of the Andes from Colombia to Argentina. It is possible, therefore, that in the future large areas in the continent, even if they are devoid of coal for metallurgical industries, will be able to derive power for general purposes from petroleum.

With its wealth of rivers and waterfalls the South American continent is very rich in potential hydro-electric power. Apart from the great falls, such as those on the Iguassú and the Paulo Affonso Falls on the São Francisco, there are hundreds of other

cataracts that are capable of supplying electric current. South American rivers are not only remarkable for the number of their waterfalls and for the volume of the water that passes over them, but they afford two further advantages in that they never freeze and in few cases are subject to low water. In the last 20 years power stations have been erected in Eastern Brazil and Southern Chile to supply towns and industrial undertakings, and the number is rapidly increasing. What has been done so far is only the merest fraction of what is possible in the future. Were it not for the very serious obstacle of labour shortage and of high wages, there is no reason why certain parts of South America which are favoured with practically unlimited supplies of cheap water power, should not eventually become important industrial areas.

VI. THE UNINTELLIGENT EXPLOITATION OF RESOURCES WITHOUT REGARD FOR THE FUTURE. The abundance of natural resources in proportion to the small population, together with the lack of means of disposing conveniently of the surplus, has made the average South American somewhat careless in his methods of exploitation. The rich guano deposits of the Peruvian coast have been almost exhausted. The ruthless and primitive manner in which rubber has been extracted from the Amazonian forests, and cinchona bark from the Montaña region of the Eastern Andes, are classical examples of South American methods at their worst, but other and less wholesale processes of destruction of resources have been going on all over the continent.

The desire to get wealth quickly at whatever cost, or rather without regard for the future, which animated the early Spaniards and Portuguese in South America, has lingered on. The hasty and unfortunate methods that this motive prompts have been the more firmly established through the chronic lack of capital and shortage of labour. Notwithstanding some striking exceptions, primitive forms of cultivation and husbandry are still very much the rule in tropical South America. For these the Indian strain in the population is very much to blame. The native appears to lack the foresight, the adaptability and the intelligence necessary to live otherwise than in the simple hand-to-mouth way of his forefathers; and the European estate owner, even when he wants to introduce sound and scientific methods, finds himself thwarted by the inertia of the Indian element on which he has to rely for labour.

It is true that Anglo-Saxons were responsible for an even more wholesale exploitation of natural resources in North America, but their methods were characterized rather by an excess of energy than by a slipshod conservatism, and they

were dealing eyes open with the fairly well-known and well-understood behaviour of nature in the temperate regions. It is only recently that tropical agriculture has been the object of scientific study and organization in any part of the world, and it is scarcely surprising therefore that over much of tropical South America rational and organized plantation methods of production have as yet scarcely begun. Yet the change will have to be made if the volume of the products is to be increased or even maintained. Nature alone will generally produce something at the outset in the tropics as in the temperate regions, but if intelligently directed labour on man's part is wanting, if existing resources are simply exploited, little or nothing is eventually forthcoming. The wealth of the tropics is illusory ; it dazzles when first approached ; it soon vanishes, unless labour and selective processes are applied from the beginning.

One of the problems that will have to be attacked before long in the agricultural areas of South America is that of maintaining the fertility of the soil. So long as stock-rearing was the main method of utilizing the land, there was little danger of impoverishing the soil ; but the now widespread cultivation of maize, particularly in Brazil and Argentina, of wheat and linseed on the Pampa, and of coffee and cocoa in the tropical parts, together with the growth of large consuming towns in the continent and of an extensive export trade in agricultural produce, tends to exhaust the land in the more accessible and populous cultivated districts faster than it can recover unaided. Tropical soils originally covered with forest, unless subject to periodical inundation, are particularly liable to be poor in nitrogen.

The Great Industries of the Continent and their Future Prospects

I. MINING. From the account given of the various regions of South America in the preceding chapters, it will be clear that mining is still, as it has been in the past, an important industry in a number of South American countries, especially in Bolivia, Peru, Chile, Colombia and Brazil. In considering the future of the industry, several points have to be borne in mind : firstly, the distinction between exhaustible and practically inexhaustible deposits ; secondly, the question of the accessibility of the deposits ; thirdly, to what extent competitive sources of supplies of minerals are likely to be worked in other parts of the world ; and the possibility of discoveries of further rich deposits in South America.

To begin with the first of these points, there is no doubt that some of the existing forms of mining in South America are

destined to be relatively short-lived, as others in that continent have been in the past, and as most forms of mining tend to be throughout the world. The known and easily worked gold deposits of Brazil now seem to be more or less exhausted. Silver-mining in the Andes has passed its zenith, partly because the best deposits have been worked over. The Chilean nitrate deposits will come to an end, as we have seen above, within measurable time. On the other hand, mineralization has been so widespread in the rocks of the elevated areas of South America, and igneous intrusions have taken place on such a scale in recent geological times, that certain mineral deposits appear to be at present practically inexhaustible. This applies to the iron and manganese ores of Brazil, the copper ores of Chile and Peru, the tin and bismuth ores of Bolivia, and the borax and the sulphur deposits throughout the Central Andes. Salt also occurs in unlimited quantities in the salars of the arid and semi-arid regions. The extent of the petroleum deposits is not yet exactly known. Though these are probably much smaller than those of North America, they are apparently greater than those of any remaining continent. Taken as a whole, therefore, the mineral deposits of South America are ample to keep the mining industry going for a long period to come.

With regard to the accessibility of the deposits, South America is less fortunate. The greater part of the great mineral wealth of the continent occurs either in the high Andes or in the interior of the Brazilian Plateau. Although the construction of railways can do much to bring mining centres into touch with the outside world, there remain in the Andes the obstacles of high and inhospitable elevations and of the barrenness of the surroundings; in the Brazilian Plateau those of great distances and high freights. With the best means of transportation, the mere carriage of minerals from the mines and of supplies thither is bound to bear a very high proportion to the total cost of production.¹

The third and fourth points mentioned above are closely related. In a competitive world the most economical available stores of minerals, all factors considered, get worked first. If new and richer deposits are found in the meantime, then attention is diverted to these. So far as South America is concerned, since it has been less carefully surveyed than most other parts of the world and mineralization is exceedingly widespread, it is safe to say that the discovery of new and valuable ore-beds is more likely than elsewhere. Since also, the mineral reserves of other

¹ Figures supplied by one of the leading mining companies in Bolivia show that railway freights account for 66 per cent of the total cost of tin concentrates as delivered at the coastal smelting works.

continents have for various reasons been more vigorously exploited, they are nearer the point of competitive, if not actual, exhaustion than those of South America. Thus, North America has already begun drawing upon the southern continent for iron ore (see note, p. 282). These two factors would point to a probable increase in the prosperity of mining in the future in South America, though their effectiveness may be largely discounted by the shortage and high cost of labour.

II. STOCK-REARING. In the account given in Chapter XIV of the Argentine Pampa region, attention was drawn to the great advance made there during the last fifty years in the rearing of sheep and cattle. Similar progress, but with less intensified methods, has been made in Uruguay, in Rio Grande do Sul and in Southern Patagonia. The developments in all these areas have arisen mainly through the introduction and acclimatization of improved strains of animals in response to the European demand for meat, wool and other pastoral products. Other parts of the continent, less favoured by nature for stock-rearing, for example North-Western Argentina and some of the central and western districts of the Brazilian Plateau, have shared recently to a smaller extent in the prosperity of the temperate stock-rearing regions of the Pampa, and the Peruvian Plateau may perhaps join the already developed areas as an important sheep-farming region.

Considerable numbers of live stock, mainly cattle and goats, are reared in distinctly tropical parts of South America: in North-Eastern Brazil, in Mato Grosso, in Paraguay, on the Llanos of the Orinoco, on the Northern Colombian plains and on the borders of the Chaco. The quality of the animals, however, is everywhere poor. Though largely of European stock, they have degenerated, incidentally no doubt, to the process of adaptation to environment. Yet in spite of some measure of adaptation they are subject to destructive diseases in the whole region from the northern coast of the continent to the borders of the Pampa. There are vast, practically unoccupied savannahs and grasslands along the southern borders of the Guiana Highlands, in the region traversed by the tributaries of the upper Orinoco and in the Western Chaco, but their development awaits not only improvements in means of access, but also and chiefly in advances in live stock hygiene in the tropics. South America will gain more than any other continent by any discoveries that are made in the direction of fighting the various plagues that now play havoc with cattle and other domestic animals in the warmer latitudes of the world.

III. AGRICULTURE. In the temperate parts of South America,

agriculture is firmly established and is generally in a thoroughly prosperous condition. The total area of fertile land sufficiently supplied with water is not as great as might be supposed, and the surplus produce available for export tends to decline owing to the rising standards of the increasing populations. Chile and Uruguay consume almost all the wheat they grow, and Argentina more than one-half. Some additions can be made in the future to the productive area by means of irrigation, but in the aggregate these cannot for the present be great. The chief means available for increasing the output of cereals in these temperate countries, short of reducing the numbers of live stock, lies in the direction of more intensive farming, but labour is scarce and the requisite traditions are lacking. There, as in other essentially agricultural parts of the world, the towns grow in population out of proportion to the country districts.

In the tropical regions of the continent, on the other hand, there are at present almost unlimited areas available for the cultivation of maize, mandioca and specialized plantation crops. It is in them rather than in the temperate South that great advances can be looked for in the future in the output of food crops, and upon them, as already indicated, the interest of the outside world is already beginning to concentrate. Though the change to systematic and rational cultivation has, as observed above, been very slow in coming, the fact that the rate of natural increase in the population of the countries of tropical South America has been greater in recent years than ever before, gives grounds for the hope that the greatest obstacle to progress hitherto, namely, the lack of human hands, will gradually be overcome.

IV. THE TIMBER INDUSTRY. For reasons that have been indicated in the regional chapters of this book, the timber industries of South America have been till recently limited to the cutting of certain specialized woods. Yet the continent contains great reserves in tropical timbers that will be drawn upon to an increasing extent as standing supplies in other accessible parts of the world become scarcer. The abundance of rivers, many of which are navigable far into the forested interior and the common occurrence outside the equatorial rain forests of fairly uniform stands containing softwoods as well as hardwoods, render it possible that the tropical and sub-tropical forests of South America will some day yield large supplies of merchantable timber. Moreover, some of the trees are of exceedingly rapid growth in their natural habitat, so that the exhaustion of reserves can be more easily guarded against there than in the originally forested areas of the Northern Hemisphere, where the forest growth has been completely destroyed. On the other

hand, the trees of the southern forests of South America, the Paraná and Chilean pines, the various quebrachos and the Chilean beeches, grow very slowly, and as, moreover, the areas covered by these trees are more or less limited, no great and lasting timber industry can develop in the continent outside the tropics.

There are good reasons for thinking that manufacturing industries are unlikely to develop in the near future in any part of South America on a scale comparable with that to which they have developed in Europe, North America or Japan. The future of the southern continent lies in other fields of development, but its resources are extensive and varied enough, and the inhabitants of the southern and eastern republics are possessed of sufficient initiative and vigour to give it a place of ever-increasing importance amongst the great productive areas of the world.

Since the above was written there has been considerable growth of manufactures for domestic markets in various parts of South America, notably in and around Rio de Janeiro, São Paulo City, Santiago and Buenos Aires. This industrial development began seriously during the war of 1914-18 when European supplies were largely cut off; it was stimulated by the collapse of prices for agricultural products and minerals in the years 1929-33; and it has been further assisted by the second Great War. With the help of protection, manufactures have made headway against relatively unfavourable conditions. For coal and industrial technique are either lacking or are poor in quality, and except in Brazil, and perhaps Argentina, domestic markets are very limited. It is true that water-power is abundant and is extensively utilized in East Central Brazil and Central Chile, that petroleum and potential water-power are available in the four North-Western republics, and that raw materials such as cotton, hides and wool and a variety of minerals including iron ore are produced within easy reach of several of the already established industrial centres. But costs of production of manufactures from these raw materials are comparatively high, and are likely to remain so while the domestic and (with some few exceptions) the only markets for the finished products are limited, while internal transport is generally poor, and there is a shortage of technicians for specialized manufactures. Though South American countries are, notwithstanding this, bent upon diversification of production for greater self-sufficiency, their economies must continue to be based in the main upon exports of primary products, rendering them highly sensitive as in the past to the course of world prices.

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The material available for the study of the physical and economic geography of South America is extremely scattered. Much of it, especially that relating to modern economic developments, is obtainable only from articles published in current geographical and trade periodicals, from the reports of special investigators and those of public utility companies, and from official and semi-official publications. Numerous books on South America have appeared, but many of these contain little except descriptions of the people and of well-known places, and are of small permanent value from the scientific geographical standpoint. The list of books given below is confined to those that have appeared more or less recently, and that have been found distinctly serviceable in writing the above chapters.

1. Books

GENERAL WORKS ON SOUTH AMERICA

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Mineral Deposits of South America. Miller and Singewald. New York, 1919.
The Republics of South America. James and Martin. New York and London, 1923.
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 Petermanns Mitteilungen, 1956. Süd-Amerika Heft; special articles and maps.

2. Periodicals

The Geographical Review, known from 1885 to 1900 as the *Journal of the American Geographical Society*, and from 1900 to 1915 as the *Bulletins of the American Geographical Society*, contains, especially in the recent issues, a number of well-informed articles on various aspects of South American geography by such writers as Isaiah Bowman, Wrigley, W. S. Tower, Mark Jefferson and A. G. Ogilvie.

The Geographical Journal has occasionally published longer articles dealing with South American subjects, such as those by W. S. Barclay on the River Paraná (1909) and on the Railways (1917). In addition, various shorter articles and notes of considerable value are scattered up and down the recent and the earlier volumes of the *Journal*.

Boletín del Instituto Geográfico Argentino. First Vol. 1879: One vol. annually from 1881 to 1901, but has appeared irregularly since the latter year. Contains some excellent articles on Argentine geography and explorations.

Boletín de la Academia Nacional de Ciencias de Córdoba. 25 Vols. between 1874 and 1918. Still appearing. Deals mainly with Natural History, but contains valuable articles on the geology of Argentina.

Petermann's Mitteilungen frequently prints longer or shorter articles dealing more particularly with the climatology and the structural geography of the South American continent, where German investigators have been especially active. Two very informative articles by B. Franze have appeared, one on the rainfall (*Ergänzungsheft*, 1907), and the other on the temperature (*Hefte* 3-4, 5-6 1929).

Bulletins of the Pan-American Union. Contain articles and notes

on current economic life of South America. Much of the matter, however, particularly in recent years, is popular in tone and scrappy in form, and affords little of value except for the study of purely business conditions.

Among other periodicals in which useful articles on the geography of the continent have from time to time appeared, are the following:

Annales de Géographie, Paris, the well-known French publication.

Geographische Zeitschrift, Munich.

Boletín de la Sociedad Geographica de La Paz.

Scottish Geographical Magazine, Edinburgh.

Journal of Geography, Chicago.

3. Miscellaneous Trade, Newspaper and Statistical Publications

Monthly Review published by the Bank of London and South America. Gives useful information on current economic conditions and developments.

Manchester Guardian Commercial Weekly.

The Times. Commercial Supplements.

South American Handbook. Published annually in London.

Colonial Office Year Book. London. Includes accounts of the British territories of British Guiana, Trinidad and the Falkland Islands.

United Nations Statistical Yearbooks, and numerous statistical and other special reports, including valuable Economic Surveys of major areas.

Statistical Publications of the various South American countries, mainly annual trade and agricultural returns. The most complete and accessible are those of Argentina, Brazil and Venezuela.

4. Other Official Publications

British Consular Reports. Formerly Command Papers, now Reports issued by the Department of Overseas Trade. Some of the recent issues have been excellent from the standpoint of economic geography.

American Official Papers issued by the Department of Commerce. Those are very numerous and fall into various groups as follows:

United States Commerce Reports, formerly issued as *Daily Commerce Reports*.

Supplements to Commerce Reports. These comprise information collected by consular officials and relating mainly to trade and economic conditions in the various countries of South America with which they deal.

Trade Information Bulletins. These are pamphlets on selected topics relating to the resources and the industries of different parts of the commercial world outside the United States. Some of the recent numbers dealing with South American subjects are invaluable sources of information for the student of economic geography.

5. South American Publications

In addition to statistical and other official reports, a growing volume of works in various branches of geographical studies by South American writers is now appearing in the leading capitals, notably Buenos Aires, Rio de Janeiro, Santiago, and Lima. Such publications, now listed in select bibliographies, already supplement those by foreign writers in English, German, and French, which for long were almost the only sources of new material and constructive ideas.

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